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ARCHAEOLOGICAL RECONNAISSANCE OF FORT SILL, OKLAHOMA

MUSEUM OF THE GREAT PLAINS
LAWTON, OK

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An Archaeological Reconnaissance of Fort Sill, Oklahoma

Assembled by C. Reid Ferring

Cover Photo

Troops E, F, H, and K of the 7th Cavalry and troops D and L of the 5th Cavalry on the old parade ground, 1890. (Photo courtesy of Fort Sill Museum)

AN ARCHAEOLOGICAL RECONNAISSANCE OF FORT SILL, OKLAHOMA

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MAPS

The Following Initialisms are used in this Report:

DFAE	Directorate of Facilities and Engineering
EIS	Environmental Impact Statement
USAFACFS	U.S. Army Field Artillery Center, Fort Sill
USSCS	U.S. Soil Conservation Service
Conservation Plan	Conservation Plan for Fort Sill
NRCR	Natural Resources Conservation Report
LETRA	Lake Elmer Thomas Recreation Area

INTRODUCTION

by

C. Reid Ferring

An archaeological reconnaissance is, as the term implies, an

The Reconnaissance Strategy

Fulfillment of the previously defined goals was approached in a manner which reflects the status of archaeological studies in the region (chapters 2, 11). The status of those studies could best be viewed as "low" with respect to both substantive results as well as theoretical and methodological approaches. This low status of prehistoric investigations meant that certain aspects of the reconnaissance would be hindered. For instance, cultural-historical interpretations of assemblages would be encumbered by the absence (or near absence) of a sound cultural-historical framework. This status similarly indicated some critical areas which would have a bearing on the evaluation of site significance: any sites or even areas which contained data bearing on the ecological history of the region would be significant owing to the near absence of such data from the region. Sites containing data bearing on the organic record of past subsistence patterns would be significant because of similar gaps in recorded data bases. Since theoretical-methodological approaches in regional investigations must be evaluated as part of the overall regional status of investigations, these factors were also considerations during research strategy formulation. Since a "management phase" of archaeological investigations was anticipated for Fort Sill, several investigations were undertaken at the reconaissance phase which would serve as nuclei for subsequent researches or which would provide data bases needed for investigations which would demand more effort than could be accomplished at the reconaissance phase. These investigations consist mainly of closely related ancillary studies, such as the geological work of Hall (chapter 4), the ethnohistoric research of Bousman (chapter 3), and the botanical research of Robertson and Hoestenbach (chapter 6). These contributions aided in the evaluation of the significance of archaeological sites located on the reconnaissance. They should also stand as contributions to further site assessments at Fort Sill, as well as to regional investigations.

The main components of the research strategy are reflected in the organization of the various contributions contained in this report. Section I, the Regional Setting, develops the regional framework for the reconaissance. The regional environment is described first, providing an overview of Fort Sill's natural setting as well as a basis for later resource patterning considerations. The archaeological and historical background briefly summarizes the results of archaeological investigations in the region and also provides a brief historical background for Fort Sill itself. Bousman's (chapter 3) compendium of biotic resources constitutes an important summary of ethnohistorically defined plant and animal uses. That chapter provides a basis for the study and evaluation of various biotic resources in the region which has long been needed. Applications of the ethnographic survey in this report will be found in the botanical survey

(chapter 6) and the sections pertaining to the resource utilization package

perspective. This is appropriate as a prelude to subsequent chapters which deal explicitly with cultural resource management. Implicit in the organization of the report as well as the flow of the investigations is the tenet that site significance, a crucial issue in cultural resource management, cannot be evaluated on an a priori basis but must be ascertained within a regionally defined research milieu. Sites are deemed as having significance within a framework of processual investigations, tailored to regionally defined problems as well as discipline defined approaches. Section IV (Cultural Resource Management) treats the known and predicted cultural resources sites at Fort Sill in a traditional manner with respect to cultural resource management. Preparation of an environmental impact statement, a crucial issue in cultural resource management, cannot be effectively prepared in the absence of a research-oriented framework from which site significance may be ascertained.

Chapter 11 treats regional research from a cultural resource management perspective, outlining accomplishments and statuses of various phases of investigations. This chapter helps develop the regional status of archaeological investigations necessary for environmental impact statement preparation. Chapter 12 treats potential impacts at Fort Sill. This proved to be one of the more imposing tasks of EIS preparation, owing to the tremendous diversity in both kind and intensity of potential impacts at a large, active training installation such as Fort Sill. Chapter 13 consists of a predictive model of prehistoric site location at Fort Sill. This is clearly a necessary component for both EIS preparation as well as future site management. The predictive model, in coordination with the estimated locations and severity of potential impacts are presented to serve as foci for the implementation of a program of site management. Chapter 14 supplements the predictive model through considerations of historic sites at Fort Sill. These were treated separately since their character and location diverge significantly from prehistoric sites, especially since many are documented in historic literature. The treatment of historic sites outlines both known and potentially significant sites and makes specific recommendations as to their future management. Chapter 15 presents a summary of the survey of planned construction areas. Chapter 16 is the environmental impact statement, derived from the reconnaissance studies. It is followed by recommendations in Chapter 17 which outline a program of continuing research and site management at Fort Sill.

Several specific studies as well as assemblage data bases are provided in appendices A – E.

Chapter 1

THE SOUTHWESTERN OKLAHOMA ENVIRONMENT

by
Britt Bousman

The regional investigation is concerned with the portion of Oklahoma that lies between the Washita River to the north and the Red River to the south. The east-west boundaries are the Post Oak-Blackjack Plant Community and the Texas-Oklahoma border, respectively. This area incorporates the counties of Beckham, Comanche, Cotton, Greer, Harmon, Jackson, Kiowa, Stephens, Tillman, and Washita. Portions of Caddo, Custer and Grady counties are included as well.

Geology - Topography

The basal geologic unit in southwest Oklahoma is a Precambrian igneous granite dated further east in the Arbuckle Mountains at 1.35 to 1.05 billion years ago (Johnson, et. al. 1972). The only exposed Precambrian rock in the region is Meers Quartzite, a metamorphic sedimentary rock near the Wichita Mountains. Directly overlying the Precambrian granites are Cambrian (600-490 million years) anorthosite granite, rhyolite, and gabbro. Surface occurrences of these igneous rocks along with jasper form the bedrock of the Wichita Mountains in the center of the region.

Overlying the Cambrian igneous rocks are a series of marine deposits dated to the Cambrian and Ordovician (490 to 430 million years). The Cambrian sedimentary rocks are mostly sandstone, limestone and dolomite while the sedimentary deposits dating to the Ordovician are mostly limestone (Mobley and Brinlee, 1967). These sedimentary rocks make up the Slick Hills to the north of the Wichita Mountains. Although sedimentary deposits were laid down during the Silurian (430-400 million years), Devonian (400-350 million years), Mississippian (350-320 million years), and Pennsylvanian (320-270 million years) periods, surface exposures of these deposits are not present in the region. The Precambrian through Pennsylvanian deposits faulted, folded, and were uplifted during the Pennsylvanian period to form the Wichita Mountains and Slick Hills. During the Permian Period (270-220 million years) shallow marine, deltaic, and alluvial sediments of red sandstone, shales, limestone, and gypsum and salt evaporites

were deposited throughout southwestern Oklahoma. These deposits often surrounded but did not cover the Wichita Mountains.

The Permian deposits have been grouped into 5 geomorphic provinces by Curtis and Ham (1972). The most extensive province is the Central Red Bed Plains covering the eastern and south-central portion of the region, thus surrounding the Wichita Mountains. This province is composed of red sandstone and shales that form gently rolling hills and broad flat plains. The Western Sandstone Hills are soft, well-bedded sandstones extending from the north-central to the eastern portion of the region. The topography of these sandstone hills is gently rolling, with occasional steep, eroding canyons. Covering a small area in the north-central portion of the region is the Weatherford Gypsum Hills. This province consists of massive gypsum deposits with a karst topography on gently rolling hills. Northwest of the Western Sandstone Hills are the Western Red Bed Plains. This province is made up of a series of horizontally bedded sandstones and shales which have eroded into a gently rolling topography. The southwestern portion of the region has a small area of Western Sandstone Hills, but the majority of the area consists of the Mangum Gypsum Hills. These interbedded gypsums and shales have eroded to form gently rolling hills with some steep bluffs and badlands. Several salt plains occur in this region.

During the Quaternary, streams and rivers deposited sands, silts, clays, and gravels that composed most of the floodplain and terrace deposits with the region.

Hydrography

The majority of the region is characterized by broad flat prairie-plains with gently rolling hills that are drained predominantly by intermittent small streams. These streams flow into the Salt Fork and the North Fork of the Red River in the southwest portion of the region

Water Resources Board 1968:25). Weather changes are brought about by the juxaposition and alternations of three major air masses; a warm, moist air mass from the Gulf of Mexico, a cooler, modified marine air mass from the West Coast, or a cold, dry air mass from the Artic (Holbrook 1967:55). The movements of these air masses tend to stimulate rapid changes in temperature, humidity, cloudiness, precipitation, and wind. Permutations of these climatic variables spatially and through the year (Figures 1-1, 1-2) produce distinct areal and seasonal climatic patterns that markedly affect the distribution and life cycles of plants and animals.

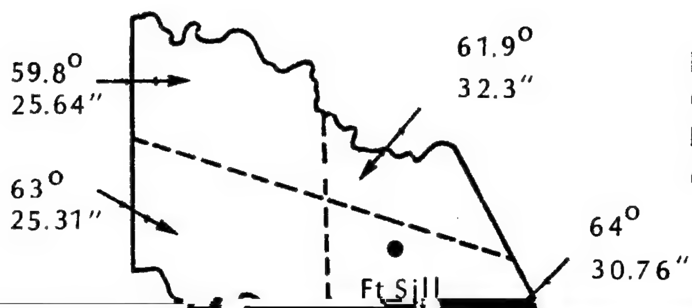


Figure 1-1. Map of Southwest Oklahoma showing gross distribution of mean annual temperatures (°F) and precipitation.

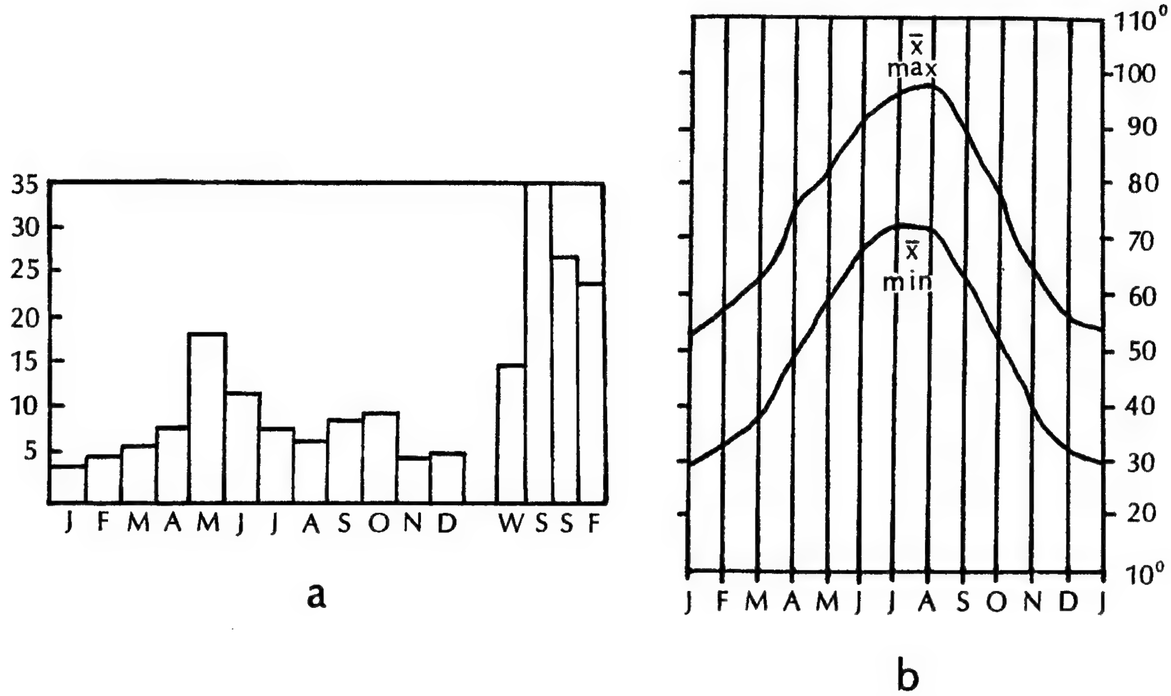


Figure 1-2. a – Average seasonal and monthly percentages of precipitation (Oklahoma Water Resources Board, 1968:25,27); b – Monthly distribution of $\overline{x}$ minimum and maximum air temperatures (^{O}F).

Summer is characterized by hot temperatures, low relative humidity, and hot southerly winds. Mean maximum temperatures range above 90^{O}F throughout the season with a peak in July and August (Oklahoma Water Resources Board, 1968:25). Occasionally thunderstorms occur, but drought conditions are common especially in late summer. Despite these severe conditions summer is a season of abundant plant resources. Many root and fruiting plants are available at this time.

There is an increase in precipitation in early fall as well as somewhat cooler temperatures. Precipitation usually drops in late fall. Concomitant with this are sunny days and cool nights. It is during the fall that most nuts ripen, but many plants begin a dormant stage.

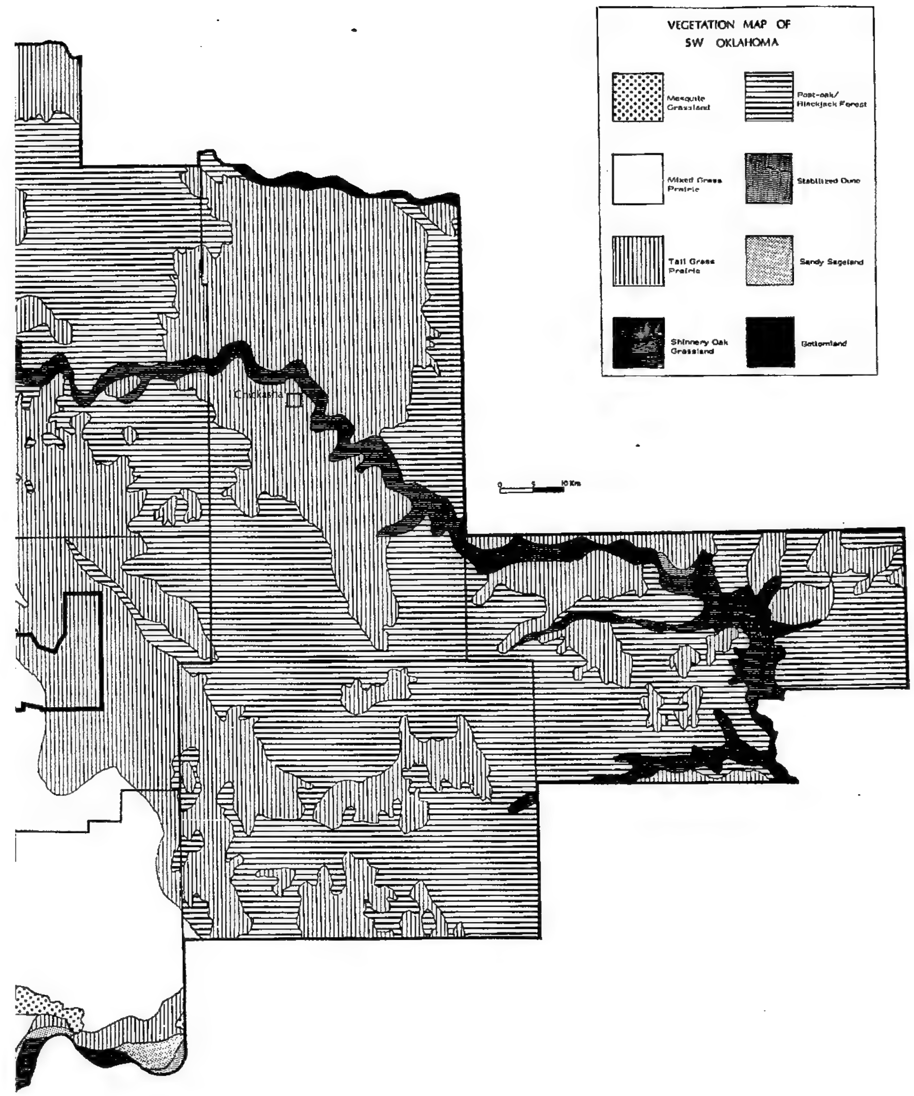
Winter is short, reasonably mild, and dry. During this season the prevailing wind direction changes from southerly or southeasterly to northerly. In the winter, "northers" or arctic air masses produce cold, often freezing, temperatures with occasional snow and ice. The first freeze usually occurs in late October or early November, and the last freeze in late March or early April. During the winter most plants are dormant, thus very little green growth is available to animals.

Plant Communities and Associated Fauna

Duck and Fletcher's (1943, 1945) Game Type Map of Oklahoma divides southwest Oklahoma into eight game types or plant communities (Figure 1-3). This distribution of plant communities and associated fauna best demonstrates the modern spatial patterning of ethnographically and prehistorically used plant and animal resources in the region. The most significant factors controlling the spatial distribution of plant communities and thus the fauna populations are the various combinations and permutations of the geology, topography, hydrology, soils, and climate. These plant communities are the Post Oak-Blackjack Forest Type, Bottomland Timber Type, Tall Grass Type, Mixed Grass Eroded Plains, Mesquite Grasslands, Shinnery Oak Grasslands, Sandsage Grasslands, and Stabilized Dunes Type. The Stabilized Dune and Bottomland Timber types are restricted to floodplain situations while the remainder are upland communities.

The Bottomland Timber Community occurs in a dendritic pattern on river and stream alluvial soils throughout the various upland plant communities. Due to the greater availability of moisture, fertility, and instability of floodplain soils the Bottomland Timber Community supports a more luxurious growth of plants and a wider range of animals than most plant communities. The commonest plants found are cottonwood (*Populus deltoides*), hackberry (*Celtis sp.*), willow (*Salix sp.*), American elm (*Ulmus americana*), post oak (*Quercus stellata*), blackjack oak (*Quercus marilandica*), chickasaw plum (*Prunus angustifolia*), sumac (*Rhus sp.*), rough leafed dogwood (*Cornus drummondii*), pecan (*Carya illinoensis*), walnut (*Juglans sp.*), buffalo grass (*Buchloe dactyloides*), blue grama (*Bouteloua gracilis*), spangle grass (*Uniola latifolia*), and wild rye (*Elymus sp.*). Animals associated with this plant community include quail (*Colinus virginianus*), squirrel (*Sciurus niger*), cottontail rabbit (*Sylvilagus audubonii*), raccoon (*Procyon lotor*), opossum (*Didelphis marsupialis*), skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), otter (*Lutra canadensis*), and whitetail deer (*Odocoileus virginianus*). Elk (*Lutra canadensis*) and bison (*Bison bison*) were present before their extermination from the region.

The Post Oak-Blackjack Oak Community is an upland grass-forest ecotone. It occurs along the eastern edge of the region, in and south of the Wichita Mountains, and on isolated granite hills scattered from the main body of the Wichita Mountains west to the North Fork. Dominant plants include post oak, blackjack oak, little bluestem (*Andropogon scoparius*), and big bluestem (*Andropogon gerardi*). It is considered good small game habitat supporting numerous quail, fox squirrel, cottontail rabbit, and whitetail deer. Elk and bison were present, although bison would have been more numerous in the grasslands.



Southwestern Oklahoma.

The Tall Grass Community is an upland community that has virtually no overstory. The majority of this community occurs west of the Post Oak-Blackjack Oak Community and east of the Wichita Mountains. The Tall Grass Community extends west along the major river floodplains of the region. Big bluestem, little bluestem, Indian grass (Sorghastrum nutans), switch grass (Panicum virgatum), silver bluestem (Andropogon saccharoides), buffalo grass, blue grama, and sideoats grama (Bouteloua curtipendula) are common plants in this community. Animals presently supported in the Tall Grass Community include badgers (Taxidea taxus), skunks, prairie chickens (Tympanuchus sp.), and coyotes (Canis latrans). Historically elk, and bison were reported to have utilized this community in large numbers.

The Mixed Grass Eroded Plains represents an ecotone between the Short Grass Plains to the west and the Tall Grass Prairies to the east. This community occurs from north to south in the central and western portion of the region, and comprizes over 60 percent of this area. Common plants include buffalo grass, blue grama, sideoats grama, and little bluestem.

The plant species composition of the Mesquite Grasslands is identical to the Mixed Grass Eroded Plains except for the addition of mesquite trees (Prosopis glandulosa). Both plant communities often occur in soils developed from Permian fine-grained sandstones, shales, clays, and occasionally in gypsum. The Mesquite Grasslands occur in the southwestern portion of the region in large concentrations and in small scattered groups between the North Fork and the Wichita Mountains. A similar range of animals are found in both communities. Included are quail, dove (Zenaidura macroura), cottontail rabbits, jackrabbits (Lepus california), coyotes, prairie chickens and in the past bison, antelope and elk.

The Shinnery-Grassland Community supports a growth of tall grasses such as little bluestem, big bluestem, sandhill bluestem (Andropogon halli), and Indian grass with small groves of several species of low growing oaks (Quercus sp.). The animals reported to inhabit this community include prairie chickens, quail, cottontail

awn (Aristida sp.), big bluestem, sandhill bluestem, Indian grass, buffalo grass, blue grama, sideoats grama, plus an abundant growth of weedy annuals and woody species such as plum and sumac. The most abundant animals within this plant community are quail, prairie chicken, dove, and cottontail rabbit. In the past, elk, antelope, and bison inhabited the community. The Sandsage-Grassland Community flanks the Red River, North and Elm Forks in the southwestern portion of the region. It is commonly associated with Quaternary sandy soils.

The only floodplain community besides the Bottomland-Timber Community is the Stabilized Dune Community. This community is found only in a small area along the North Fork on deep, loose sandy soil. These heavily vegetated dunes support a wide variety of trees, shrubs, grasses, and weedy annuals such as American elm, hackberry, chittomwood (Bumelia langinosa), post oak, blackjack oak, wild grape (Vitis sp.), plum, dogwood, skunkbush, sumac, little bluestem, big bluestem, sandhill bluestem, and Indian grass. This community is excellent habitat for small game such as quail, cottontail rabbit, fox squirrel, raccoon, opossum, skunk, and whitetail deer. Its small size could not have supported stable populations of elk, bison or antelope, but it certainly was frequented by these animals.

Early Botanical Documentation

Two mid ninetieth century explorers recorded the vegetation of southwestern Oklahoma in enough detail as to be useful to this regional study. Marcy and Keim, travel through different portions of the region in the spring and summer of 1852 and the winter of 1858, respectively, recorded a variety of environmental data. March lead the first scientific reconnaissance into the region. His party was the first to accurately map the upper Red River watershed. He also systematically collected meteorological, pedological, topographic, floral, and faunal data, while Keim, traveling with Sheridan, recorded a variety of floral and faunal information. Their botanical data are summerized below.

East of Cache Creek on the Red River, Marcy (U.S. War Dept., 1937) indicates that the valley was a well timbered bottomland. The section of his journal concerned with the botany of southern Cache Creek, near the confluence with the Red River, states that a "very dense and rank vegetation [is] everywhere exhibited" (U.S. War Dept., 1937:16). Along Cache Creek were to be found such species as burr oak, pecan, elm, hackberry, ash and wild china. West of Cache Creek in the Red River Valley, possibly ten to twenty miles to the west, Marcy recorded a change in the valley's vegetation. In Marcy's own words "upon the river there is no other timber but cotton-wood (Populus angulata) and elm (Ulmus Americana), and these in very small quanities" (U.S. War

Dept., 1937:21). It is clear from the above documents that a reduction in the density and variety of plant species occurred west of Cache Creek in the Red River Valley.

Marcy also states that west of Cache Creek, between the Wichita Mountains and the Red River was a "smooth high prairie. . . an elevated plateau totally devoid of timber" (U.S. War Dept., 1937:17,24). This prairie was terminated by the North Fork of the Red River and its tributaries which drain the western Wichita Mountains.

One of these tributaries, Otter Creek, was described by Marcy thus "I found the timber skirting its banks the entire distance and increasing in quanity as it nears the mountains" (U.S. War Dept., 1937:28). The timber was composed of pecan, blackwalnut, white ash, elm, hackberry, cottonwood, wild china, willow and mesquite, as well as blackberries, rasberries, gooseberries, currants, grapes, and plums near the mountains or on the stream banks.

Further up the North Fork, on another tributary, Elk Creek, which [illegible]

large meadow was south of Medicine Creek in the Cache Creek Floodplain with buffalo, bunch, grama, and mosquite grasses present in great luxuriance "even at the coldest part of the year" (Keim, 1970: 245).

In the valleys draining the southern slopes of the Wichita Mountains were post oak, black walnut, pecan, hackberry, elm, and cottonwood trees. Mesquite trees were found near the mountain slopes, and the grasslands south of the Wichitas were covered with "luxuriant" stands of several varieties of grama (U.S. War Dept., 1937:105, 109).

Keim (1970:141, 142, 159) describes the vegetation on the Washita River from the site of the Battle of the Washita, near Texas, east to Fort Cobb as abundant with timber and undergrowth. At Fort Cobb he indicates that cottonwood, burr oak, elm, black walnut, ash, hackberry, box elder, Osage orange, and locust trees as well as grass six feet high grew in the Washita River Valley. In the small canyons away from the river grew "quanities of cedar" and bunch grass on the hills. North of the Washita River the landscape was "high and rolling" (Keim, 1970:233) and thus a grassland. This was probably applicable to the area between the Washita River and the Wichita Mountains as well.

In addition George Catlin, an artist traveling through the region in 1834 with Dodge's Dragoon Expedition, provides some generalized hints as to the vegetation. He makes numerous references (Catlin, 1973:53-60) to the green, rolling prairies between the Cross Timbers (Duck and Fletcher's Post Oak-Blackjack Oak community) and Cache Creek.

Thus the ninetieth century records indicate that most of Duck and Fletcher's (1943, 1945) plant communities were extant in southwestern Oklahoma before intensive historic occupation. The only plant community not recorded by the ninetieth century journals was the Stabilized Dune community which is presently known from only a small area along the North Fork. No distinctions were made between the Tall Grass and Mixed Grass communities by these explorers, but this is not surprising since the relationship is clinal, not distinct as between a grassland and timbered community. It also seems apparent that the general locations of these plant communities are also very similar. It is suggested herein that there was little change between the undisturbed ninetieth century plant communities and Duck and Fletcher's plant communities of 1943.

Chapter 2

The Coenonten site, located in 'Kieun-C

Other Archaic habitations in the region are largely known from cursory reports resulting from surveys (Burton and Burton, 1971), or are workshop-type sites (Hofman, 1973; Saunders, 1974). The latter have emphasized the use of Ogallala quartzite during the Archaic, apparently as part of an overall pattern of local resource utilization.

Synthesis of the Archaic have relied on this meager data base to accomplish several classifications of Archaic assemblages (Schaeffer, 1966 a & b; Leonhardy, 1966 b). In view of the paucity of dated assemblages as well as assemblages which may be associated with subsistence data, these classifications must be viewed as premature. Considerably more evidence relating to patterns of technological, typological and economic change are necessary preludes to any systematic treatment of diachronic and synchronic cultural variability.

The Woodland Stage

The Woodland period is that in which horticulture and ceramics made their appearance on the Plains. The former is obviously the more important of the two changes, and theoretically is related to substantial changes in the lifeways of indigenous cultures. The processes by which horticulture appeared, as well as the nature of the cultures which accepted it, are poorly known in the Southern Plains, and even more poorly documented in the study region. In scattered areas of the Southern Plains and surrounding regions it may be surmised that Woodland characteristics appeared shortly after the beginning of the first millenium A.D. Local variability in these changes must be anticipated, and it is inappropriate to assume that they were present in the study region as early as elsewhere.

Dates from the Pruitt site in south central Oklahoma suggest that by ca. 700 A.D. Woodland-like assemblages, as well as horticultural economies were present (Barr, 1966). Cord-marked pottery and stemmed or side-notched projectile points characterize the assemblage. To the north of the Pruitt site, the Brewer site (Duffield, 1953) and the Duncan-Wilson Shelter (Lawton, 1968) also have Woodland components. Studies of these sites have failed to shed much light on

bone and mussell shell in association with an assemblage which contained cord-marked pottery (Schaeffer, 1961). These materials were quite deeply buried, suggesting some antiquity, yet the small samples and the lack of dates prohibit assignment of cultural affiliations.

The Plains Village Stage

The Plains Village Stage is characterized by broadly similar cultural complexes in the Southern Plains; these complexes are marked by village settlements, mixed horticulture/hunting economies and broadly similar lithic, ceramic and bone material cultures (Ferring, Spivey and Crouch, 1976:28-35). There is little resolution in the definition of the Plains Village manifestations in southwestern

(Lintz, 1974:41). Artifact assemblages are characterized by cord-marked and plain ceramics, small triangular projectile points, scrapers, bevelled knives, and a number of bone tools (Bell and Baerreis, 1951; Hofman, 1975; Lintz, 1974).

A larger number of sites in the Washita Valley have been assigned to the Washita River Focus (Bell and Baerreis, 1951; Bell, 1961, 1968; Lintz, 1974). These sites generally occur to the east of the

radiometrically to ca. 1400 A.D., and appears to be a rather small Plains Village site with undefined cultural relations to surrounding complexes. The lithic and ceramic assemblages could relate to local, easterly or westerly (Panhandle Aspect) groups.

The Protohistoric and Historic Stages

First evidence of native cultures' contacts with the Europeans is significantly lacking in the region. Excursions of Europeans into the Southern Plains in the sixteenth century A.D. are well documented, but the subsequent period is practically unknown archaeologically in southwest Oklahoma. A possible candidate for this period is the Wheeler complex (Bell and Bastian, 1967), although this candidacy admittedly derives from the scanty information available. The complex is known from surface assemblages marked by a few European trade goods in association with an otherwise late prehistoric assemblage. The latter includes generally dark, plain (or lip-decorated) sand-tempered ceramics, small triangular projectile points and an abundance of scrapers. This complex is known from very few localities in southwestern Oklahoma, and most likely relates to an early historic Wichita complex, perhaps a southern contemporary of the Great Bend Aspect in southern Kansas (Wedel, 1959). The absence of excavated material in good context, as well as dates for these assemblages make evaluation difficult. Certainly the association of trade goods with surface assemblages should be interpreted with caution.

The full historic period is better represented, with components of the Norteño Focus-the archaeological taxon for the historic Wichita groups-being represented in the region. This complex, originally defined by Duffield and Jelks (1961) is known mostly from north Texas [illegible]

located on the Oklahoma side of the Red River is one of several Oklahome manifestations of the complex (Bell and Bastian, 1967). Other sites in northern Oklahoma, notably the Deer Creek site (Sudbury, 1976) are also historic Wichita sites, yet historic relations with the southern sites are still being defined.

Norteño sites characteristically contain abundant European trade items in association with the native material culture. Guns, knives, axes, metal ornaments, glass trade beads, and other items indicate the intensity of trade during the eighteenth and early nineteenth centuries A.D. when most of the Norteño sites were occupied. Fortifications, such as those at the Longest Site, were a response to trade related conflicts on the Southern Plains. Parilla's attack of the Longest

Site in 1759 is one of the most notable events of the period (Bell and Bastian, 1967).

The gradual addition of the horse and gun to the native technology most certainly had a dramatic effect on patterns of subsistence, cultural intercourse, and basic aspects of social structure. These newly acquired traits, in addition to the potentially more important economic changes which surrounded increasingly intensive trade activities, have not been adequately studied. Relatively scant ethnographic records of the historic Wichita provide only the most general implications concerning the patterns of change during the early historic period (Newcombe and Field, 1967). Potentials for archaeological contributions to these problems have not been met. Important information from certain investigations, such as Stephenson's (1970) work at sites along the Brazos suggest an economy based on hunting of bison, small game as well as some aquatic resources. Lorrain's (1967) work at the Gibert site indicates hunting of deer possibly predominated, while a broad range of small game and aquatic resources were exploited. These archaeological accounts differ from some of the ethnographic studies, and testify for the need of intensive archaeological documentation of them.

The later events of the historic stage, notably the immigration of the various Athabascan, Shoshonean and Tanoan/Aztecan speaking groups have recently been described in some detail (Spivey, et. al., 1976:19-24). The role of these groups-the Comanche, Kiowa, Kiowa-Apache and Apache, as well as the native Wichitas, in U.S.-Indian affairs is a major chapter in the history of the American West. Southwestern Oklahoma was the scene of numerous important historical events during this period, and Fort Sill was an integral aspect of that history.

Fort Sill: A Brief History

Fort Sill presently serves as the Field Artillery Center of the United States Army. Initially, however it was an isolated post intended to represent with the Indian Agency the best interests of the Federal Government on an extensive Indian Reservation. Through the intervening years, colorful events and individuals have accompanied these changes in mission.

The beginnings of the Post's existence date back only to 1868 when raiding by the Kiowa and Comanche into Texas in violation of the 1867 Medicine Lodge Treaty prompted the Army to mount a multipronged punitive expedition into western Oklahoma. The purpose was

to disrupt the Indian's war-making abilities and to punish them for past depredations. This was successfully carried out and a winter encampment made at Fort Cobb near the only existing white settlement in the Kiowa and Comanche Reservation. However, because of poor conditions in the area, this encampment was relocated to Medicine Creek near where Fort Sill now stands. It was then decided that this would become a permanent post to help prevent the conditions which had caused the 1868 expedition. The temporary quarters of the soldiers consisted of rude dugouts covered with canvas, of tents, and of log houses as soon as it was realized that the assignment would become permanent. These were located on both sides of Medicine Creek upstream of the later Old Post area as far as Heyl's Hole.

behind the sutler's store in what is now the "New Post" area. Satank was later killed trying to escape en route to incarceration in Texas while the other two were released on parole in 1873. Within a year, the last major outbreak of hostilities was to occur.

The raiding and almost constant violence which created the Post initially and characterized its early years, began quickly to wane after 1875. As it continued through the latter part of the century the Army's purpose gradually changed so that rather than acting to contain the Indians, it served to protect them and their properties from outside opportunists. This reorientation is well exemplified by the 1894 transfer to Fort Sill of the Apache Geronimo and the remnants of his band. Here they were held under the fiction of "prisoners-of-war" both so that they might not return to their native Southwest where local populations feared them and so that the government might provide them with supportive services until they could learn to adjust to a [illegible] world. In a short time, they were living in government [illegible]

maintain the peace until civilian authorities could be empowered. The city of Lawton which even today maintains close ties with the Fort was founded and smaller civilian communities also mushroomed over the region. Fort Sill's relationship vis-a-vis the Indians ended.

A new direction for Fort Sill was not long in coming. In the next decade it ceased to be a cavalry post and instead, because of a favorable terrain and climate, became a field artillery post. The School of Fire was established and the "New Post" area was constructed to accommodate this new mission. Since then its position as a center for the training of field artillerymen has remained unchanged. Of course, many expansions and modifications have been made in the Post garrison since 1911 when the School of Fire was first established. For example, Fort Sill was once the center of the Infantry School before it was moved to Fort Benning while during World War I thousands of troops including the later President Harry Truman were trained at Camp Doniphan. Even today it has begun to supply Basic Combat Training under the One Station Training program.

Those portions of the original Post which still remain have been accorded the status of a National Historical Landmark. Many sites with important historical associations have not yet been recognized officially. These offer fertile ground for scholarly study and are discussed in more detail elsewhere with recommendations toward their preservation (see Chapter 14).

Chapter 3

BIOTIC RESOURCES OF THE FORT SILL AREA: AN ETHNOGRAPHIC VIEW

by
C. Britt Bousman

The main body of this section provides a documentation of foods used by the Indians of the Southern Plains and the manner by which these resources were obtained. This composite list, drawn from ethnographic studies on a number of groups (the Comanche, Kiowa, Wichita, Plains Apache, Caddo, Cheyenne, and Missouri River Tribes of Gilmore) was compiled rather than a group specific list, in order to provide a generalized set of ethnographically known foods applicable for regional archaeological studies. It is suggested that a compendium of this sort is long over due for the Southern Plains, and it is at this initial stage of archaeological research, the reconnaissance, that these data should be integrated into a long term research design.

The following discussions will demonstrate that the tribes of the region had an intimate knowledge of the environment and that from a large number of available foods they utilized a smaller set.

Each resource or group of similar resources were exploited by specific extraction and preparation techniques along with the necessary technology. Flannery (1968:69) has called this set of activities and [illegible]

botanical works, or from the monographs by Correll and Johnson (1970), Gleason (1968), Kirk (1970), Stephens (1969), Steyermark (1963), and Vines (1960), or from the project biologists: Jim Robertson and Roger Hoestenbach. The scientific and common names of the plants are presented in phylogenetic order along with the preferred habitat(s), how a group used a plant, and the season(s) of its availability. This is augmented by a discussion of plant food procurement in the plains.

The common and scientific names of the animals precede a "character sketch" which is itself followed by a discussion of animal procurement systems.

Plant Food Procurement

In the Southern Plains three groups of plants were collected and eaten by the various Indian tribes; fruits, roots, and nuts. The fruits that were eaten include plums, blackberries, yucca, prickly pear, mesquite, clove currant, mulberries, persimmons, hackberries

and grapes. Roots utilized include sunflower, milkweed, cattail, bulrush, thistle, wild onion, and of course wild buckwheat and pomme blanche. Pecan, black walnut with burr, blackjack, post, and black oak nuts were also eaten.

The most comprehensive study of plant procurement in the Plains is by Grinnell on the Cheyenne. Grinnell (1972a:66) states that "groups of women and young girls went out into the hills to gather roots, and were seen walking across the wide prairie, armed with their root-diggers, and then climbing the hills, and at last-mere dots in the distance-scattered out and occupied in their work." Apparently the women gathering parties left and returned to camp each day (Grinnell, 1972a:67). The Cheyenne had a number of different types of root-diggers or digging sticks. Iron bars were used in modern times while before iron was available wooden sticks with fire hardened points were used. Farther back in time pointed elk antlers were used

lly known uses	Seasonal Availability
ant.	Spring
ruits.	Spring, summer
ots raw, nd ground	Summer, fall, winter
tribes pers.	1. Summer, fall
ung	2. Spring
raw,	3. Summer, fall
ups	

Use	Seasonal Availability
ssouri River tribes tender base of stem	Spring, summer, fall
ddo ate entire plant boiled, roasted amed bulbs which lso dried for winter.	Spring, early summer
ssouri River tribes plant raw, fried, or with meat or soups.	Spring, early summer
manche ate roasted	Spring, early summer
ddo used fruits in bread, and jelly.	Spring
ssouri River tribes ts.	Spring
owa ate young stems. , and ods.	1. Late spring 2. Late spring, early summer 3. Summer

	Seasonal Availability
ıe nut.	Fall
ɔuri ɛ plain, soup. raw or uts.	Fall
tribes ash to	Fall
s, also corns.	Fall
ıs raw, .nto meal nd bread.	Fall
ıunded,	Fall
corns rns.	Fall

Table 3-1. C inued.

	Habitat	Use	Seasonal Availability
Family)			
)	Sandy loam, rocky, or alluvial soils	1. ne Comanche mixed fruits th fat to eat. 2. ne Caddo ate fruits raw or ied for winter use.	Fall
s rry)	Sandy or rocky alluvial soils	1. ne Kiowa pounded berries to paste, moulded on a ick and cooked. 2. ne Missouri River tribes unded berries and mixed is with meat or corn.	Fall
a	Moist alluvial soils	1. ne Caddo made inner bark to cakes.	All year
	Alluvial woodlands and thickets	1. ne Kiowa made tea from ner bark, which was dried d stored for winter use, or 2. ed inner bark as a masti- tory. 3. ne Caddo made cakes from ner bark.	All year
rry Family)			
	Upland or alluvial woodlands	1. ne Comanche ate fruits. 2. ne Caddo ate fruits raw or ied for winter.	Late spring, early summer

Table 3-1. Continued

Plant	Habitat	Use	Seasonal Availability
POLYGONACEAE (Buckwheat Family)			
Eriogonum longifolium (Longleaf wild buckwheat)	Dry sandy soils in grasslands	1. The Kiowa ate roots.	Summer
PHYTOLACCACEAE (Pokeweed Family)			
Phytolacca americana (Common pokeberry)	Disturbed or rich soils	1. The Caddo boiled the shoots for greens.	Spring
PORTULACACEAE (Purslane Family)			
Claytonia virginica (Virginia springbeauty)	Rich sandy soil	1. The Caddo ate corms.	Spring
NYMPHAEACEAE (Water Lily Family)			
Nelubo lutea (Water lily)	Lentic aquatic habitats	1. The Kiowa and Caddo cooked the tubers. 2. The Caddo ate seeds raw or roasted for winter.	1. All year 2. Late summer, fall
CRUCIFERAE (Mustard Family)			
Lepidium sp. (Pepper grass)	Sandy soils	1. The Caddo used seeds for seasoning.	Summer
SAXIFRAGACEAE (Saxifrage Family)			
Ribes odoratum (Clove current)	Cliffs, rocky slopes, or sandy bluffs	1. The Kiowa ate fruits raw or as a jelly. 2. The Comanche ate fruits.	Summer

Table 3-1. Continued

itat	Use	Seasonal Availability
voody imestone hilltops	1. The Comanche ate fruits.	Fall
dland soils	1. The Kiowa ate fruits fresh or dried for winter use. 2. The Cheyenne ate fruits green or cooked fresh or dried. 3. The Missouri River tribes ate fruits fresh, dried for winter, or cooked as a sauce.	Summer
sterile soils uations	1. The Comanche stored fruits or ate them fresh. 2. The Caddo ate fruits fresh or in cakes.	Late spring, early summer
pes and thin andy or dryish	1. The Kiowa ate fruits fresh or dried for winter. Fruits were cooked into cakes or candy.	Summer
rests or s	1. The Caddo ate fresh fruits or made into cakes.	Summer

	Seasonal Availability
River tribes h or dried, and akes. Gathering s a community	Summer
ate fresh or akes or	
fruits fresh inter use.	
ate fruits for winter	Summer
ache and uits.	
fruits fresh ter.	Summer
always ate	Summer
the fruits for winter.	Early summer
ate the berries. River tribes ate h or dried for	Early summer

asonal Availability
mmer
te spring
ring, summer
mmer
mmer
ring

Use	Seasonal Availability
souri River tribes and roasted the	Summer through winter
va pounded beans into meal.	Summer through winter
anche ate meal nded bean pods.	Summer through winter
souri River tribes e roots, and ate cooked or dried for se. venne ate large roots dried.	Late spring, summer
anche ate roots.	Late spring, summer
do ate seeds raw or	Summer
horticultural- re groups.	

Table 3-1. Continued.

Habitat	Use	Seasonal Availability
mily)		
sslands	1. The Kiowa made into chewing gum.	
y)		
hills, woods, sand es, and rocky soils	1. The Kiowa ate berries or made into a drink.	Summer
sandy hillsides	1. The Caddo peeled and ate raw shoots. 2. The Comanche children ate fruits.	1. Spring, early summer 2. Summer
rocky uplands and dplains	1. The Caddo peeled and ate raw shoots.	Spring, early summer
careous soils in and forests and lines	1. The Missouri River tribes used for sugar.	Late winter, spring
st alluvial soils	1. Grapes eaten raw, dried or as a jelly by Kiowa. 2. The Missouri River tribes ate fruits raw or dried for winter, or 3. drank sap.	1. Fall 2. Fall 3. All year

nued.

Use	Seasonal Availability
e Caddo made a drink om fruits and dried grapes winter.	Fall
e Missouri River tribes e fruits fresh or dried for nter use, or	1. Fall
ank sap.	2. All year
e Cheyenne ate fruits fresh.	3. Fall
e Comanche ate fresh iits or dried fruits for nter consumption.	Fall
e Caddo ate fresh leaves.	Spring, summer
e Cheyenne dried fruits. e flesh minus the seeds s added to stews and soups.	1. Summer
e Missouri River tribes ate its raw, stewed, or dried winter use.	2. Summer
e Caddo ate fruits raw or led.	3. Summer

able 3-1. Continued.

	Use	Seasonal Availability
	4. The Kiowa ate fruits raw or as a candy.	4. Summer
	5. The Comanche ate fruits.	5. Summer
	6. The Missouri River tribes ate pads as famine food.	6. All year
	7. The Caddo roasted pads.	7. All year
nd or	1. The Kiowa used mucilaginous sap from outer bark as a chewing gum.	All year
	1. The Comanche ate fruits raw or dried. 2. The Caddo ate fruits raw, in cakes, bread, beer, or dried for winter.	Late fall
ls	1. The Caddo cooked cambium.	All year
yey	1. Milky latex used as a masticatory by Kiowa.	All year

Table 3-1. Continued.

Plant	Habitat	Use	Seasonal Availability
ASCLEPIADACEAE (Milkweed Family)			
Asclepias tuberosa (Butterfly weed)	Various habitats	1. The Caddo derived sugar from flowers, 2. ate young shoots as greens, 3. boiled tubers, and 4. young seed pods.	1. Spring, summer 2. Spring 3. Summer 4. Summer
Asclepias verticillata (Whorled milkweed)	Dry upland soils	1. The Caddo boiled and ate seed pods and 2. tubers.	1. Summer 2. Summer, fall
Asclepias viridis (Green antelope horn)	Dry soils	1. The Caddo ate boiled seed pods.	Summer
Asclepias sp. (Milkweed)	Various habitats	1. The Missouri River tribes ate young sprouts, 2. clusters of floral buds, and 3. green fruits. 4. The Cheyenne ate green buds and, 5. fruit. 6. The Kiowa ate young fruits.	1. Spring 2. Late spring 3. Late spring 4. Spring 5. Late spring 6. Late spring
CONVOLVULACEAE (Morning Glory Family)			
Ipomoea longifolia (Narrowleaf morning glory)	Sand or sandy-clay grasslands	1. Roots were a famine food of the Kiowa.	Summer

Table 3-1. Continued.

Plant	Habitat	Use	Seasonal Availability
LABIATAE (Mint Family)			
Mentha sp. (Mint)	Moist soils	1. The Kiowa chewed fresh leaves or made a tea.	Spring, summer
SOLANACEAE (Nightshade Family)			
Physalis lobata (Purple groundcherry)	Various habitats	1. The Kiowa made jelly from berries.	Summer, fall
PLANTAGINACEAE (Plantain Family)			
Plantago sp. (Plantain)	Variety of habitats	1. The Caddo ate leaves raw or cooked as greens.	Spring, summer
CUCURBITACEAE (Gourd Family)			
Citrullus sp. (Domesticated melons)		1. Grown by various tribes.	
Peppo sp. (Domesticated squashes, pumpkins, and gourds)		1. Grown by various tribes.	
COMPOSITAE (Sunflower Family)			
Cirsum ochrocentrum (Yellow spine thistle)	Open areas, especially disturbed soils	1. The Kiowa ate roots.	All year

bility

Buffalo (Bison bison)

The mean weight of adult bison ranges from 1880 pounds for males and 700-800 pounds for females. Bison occur in the greatest numbers and highest densities on the grasslands, although bison were probably found in all habitats within the region.

Bison are grazers and only infrequently will they browse. Favored foods of bison included blue grama, buffalo grass, little bluestem, sideoats grama, windmill and wheat grass, black grama, hairy grama, dropseed, and several species of fescues, as well as some broad-leaved nongrassy forbs.

The gregarious and diurnal bison's behavior can be divided into two gross categories: feeding and nonfeeding (McHugh, 1972: 155). Feeding behavior includes a short walk to feed and eating. Nonfeeding behavior includes loafing or lying, ruminating, traveling, watering, playing and grooming as well as rut associated behaviors. Feeding behavior begins at or just after dawn. Towards noon feeding stops and nonfeeding behavior occurs, especially loafing and sleeping. Bison begin feeding again in the afternoon and this lasts until dark. During winter less midday nonfeeding behavior occurs.

Daily distances traveled varies, but in general distances are shorter during rutting season and winter. Greater daily movements occur as the availability of water sources decreases. The famous long distance seasonal treks espoused by Hornaday (1889:423, 424), Garretson (1934: 23-24), and others have not been substantiated by detailed studies of historical records (Roe, 1951: 521-542) nor are they suggested by modern bison studies (McHugh, 1972). McHugh

bull groups are composed of mature bulls and infrequently an old cow. The cow groups are composed of cows, calves, and immature bulls. Solitary, isolated bulls also occur. During various times of the year, but especially during the rutting season, cow groups coalesce. At this time the bulls join an established cow group and the bull groups dissolve. Rutting season begins in the Wichita Mountains Wildlife Refuge by early June, but is most intensive during late June and July (Halloran and Glass, 1959:369). Calving occurs in the refuge in March and April.

There is great variation in recorded herd sizes. Estimations range from 4,000,000 (Hornaday, 1889:390-391) to isolated individuals (U.S. War Dept. 1937:114) Roe (1951:361) discusses an article in Forest and Stream where Horace Jones, an army interpreter, in 1859 "passed through continuous herds for over sixty miles" in Southwest Oklahoma. But Marcy, within this same region in 1851, saw only a few isolated bulls or small cow groups numbering four or less (U.S. War Dept., 1937).

Bison Procurement

The procurement of bison for all of the historic Southern Plains tribes was a very important year round activity because the bison above all other plant and animal species dominated not only the diet of these tribes but many and far reaching aspects of their lives.

Amazingly little from a bison's body was not eaten. Most groups ate not only the lean meat, but the viscera, most of the organs and these often raw just minutes after the kill. Warm, fresh blood was drunk sometimes mixed with the contents of a cows udder or the gastric juices. Tallow was eaten raw and cooked; bone marrow was eaten warm, and the bones then boiled for their fat or "grease." What remained of a bison's carcass functioned as a storehouse of raw materials for a group's clothing, shelter, or industrial needs.

The bow and arrow were used by all the later groups in the Southern Plains (Newcomb and Field, 1966;8; Möllhausen, 1858:116; Grinnell, 1972a:263; Newcomb, 1961) and by the Plains Apache in prehorse times (Bolton, 1916:227-230; Hammond and Rey, 1953:853-40. Another weapon favored by equestrian hunters, but less so by pedestrian hunters was the lance (Bolton, 1916:230; Grinnell, 1972a:263; Newcomb, 1961). Bison and other animals were hunted with firearms as they became available, but the bow and arrow and lance remained the favored hunting weapons (Newcomb, 1961:162). Two unusual methods for killing

bison were recorded by Grinnell (1972a:250, 264) for the Cheyenne. A gifted individual was known to have killed a bison by throwing a rock, hitting the skull, while mounted hunters were known to occasionally kill bison with butcher knives.

The hunting techniques employed to kill bison can be classified using two basic criteria. The first is whether the technique was used by individuals and small groups of hunters or if it was a large communal and cooperative hunting technique; the second is whether the technique was used by pedestrian hunters, or equestrian hunters or by both.

Small group or individual hunting techniques could have been used by both the mounted or pedestrian hunter. One basic technique, often incorporated with many of the other techniques was stalking, that is approaching an animal by stealth. In reference to hunting bison in the Southern Plains, stalking has been recorded for the Comanche, Kiowa, Kiowa-Apache (Newcomb, 1961), but as this technique was an integral part of many others most tribes probably used it. The Comanche (Wallace and Hobel, 1952:60) also disguised themselves with animal skins while stalking bison. The Plains Apache used this technique for hunting antelope (Lehmann, 1927:81-82) and it was likely used for bison hunting as well. Another Plains Apache technique was ambushing bison from bush blinds built near waterholes. This was witnessed by Zaldiva in 1591 and Oñate in 1601 and is one of the earliest recorded techniques for hunting bison in the Southern Plains (Bolton, 1916:230; Hammond and Rey, 1953:404). A white Apache captive in the mid 19th century told of roping a bison calf which he then shot with arrows (Lehmann, 1927:135-136). This does not seem to have had much popularity and was related as being inefficient.

Historically, all Southern Plains tribes hunted bison in large communal hunts, which many times required the cooperation of the entire group, men, women and children. The hunt often involved a camp relocation and many hours work preparing and preserving the meat, skins, and all the array of material goods derived from bison.

If bison were in small scattered groups, individual or small groups of hunters were allowed to hunt them freely, but when bison formed large herds or groups many tribes had strict rules forbidding individual hunts. The large cooperative hunts took place when bison were in large groups as the communal hunts were the most efficient and productive (Grinnell, 1972a:262). The cooperative hunts were often conducted according to a strict set of rules. Many tribes had societies and groups, usually warrior societies, to insure that the rules were obeyed during the

hunt (Newcomb, 1961:197) while other tribes, such as the Comanche, were more lax (Wallace and Hoebel, 1952:56-57). Either way the communal hunts required a great deal of individual cooperation for the good of the group as a whole and all tribes conducted communal hunts. Again most of the communal hunting methods were developed by pedestrian bison hunters and simply continued to be used with horses. Indians were first seen using horses in the Southern Plains in the second half of the seventeenth century; unfortunately very little is known of prehorse times in this area (Newcomb, 1961:86-87).

A common communal hunting technique used with and without horses was the surround. Many tribes, including the Apache, Comanche, Kiowa, Kiowa-Apache (Newcomb, 1961; Wallace and Hoebel, 1952) and the Cheyenne (Grinnell, 1972a), used this technique. It consists of hunters locating a large bison herd and then quietly and with stealth surrounding the bison on the leeward side first and carefully connecting the flanks of the circle on the windward side last. At this point the hunters move in, attempting to keep the bison within the human enclosure and milling about while killing them with weapons of one sort or another.

Pounding is a modified surround technique, but recorded rarely for bison in the Southern Plains (Grinnell, 1972a; Schroeder and Matson, 1965:62). This method requires the construction of a corral usually of timber but sturdy enough to hold bison. Often the landscape or fences which converge at the opening of the corral are used to channel the animals into the corral. A herd is then partially surrounded by a group often including women and children as well as men, who then attempt to "drive" or stampede the herd into the corral. Once this is

precipice by partially surrounding bison and "driving" them over the edge. The Comanche (Wallace and Hoebel, 1952:55), the Kiowa and Kiowa-Apache (Mooney, 1898:309) and probably most other groups used this technique when the situation offered.

Even though a hunter's efficiency greatly increased with the use of horses, only one major new hunting innovation took place with them, the chase. With a horse, if a surround failed and the bison escaped, the hunter could pursue the bison and if necessary use the horse's speed as well as its body for protection (Grinnell, 1972a: 269-270). Besides the Cheyenne, the Comanche (Wallace and Hoebel, 1952; Gregg, 1954:371), the Kiowa and Kiowa-Apache (Newcomb, 1961), and the Wichita (Newcomb and Field, 1966:8; Mollhausen, 1858:116) used this technique. Because other animals were not so easily chased, this method was used almost exclusively for bison (Gregg, 1954:378, 417). It was so successful that the chase nearly superseded all other communal hunting techniques in historic times.

Even the location of bison, especially the large herds, was at times a specialized activity. Most major economic faunal species, including bison were usually located during the act of hunting, but when the normal range of activities did not locate bison and the group was in need of food special "scouts" were sent out to find herds (Grinnell, 1972a:258; Wallace and Hoebel, 1952:57). The Comanche also believed that other animals, such as the horn toad, could indicate where bison herds were (Wallace and Hoebel, 1952:61-62).

Elk (*Cervus canadensis*)

The average weight of male elk varies from 427 to 730 pounds while average female elk weights have been recorded from 411 to 562 pounds. Elk seasonally inhabit all major plant communities.

Elk are both grazers and browsers. A Study of the Tule Elk in Owens Valley, California (McCullough, 1971) offers a generalized model of seasonal food uses. During the spring new green growth, especially the annual forbs (*Erodium* and others), offer abundant and highly nutritious forage at a time when the winter food supply is declining. Summer is a time of nutrient abundance and as the spring annuals are drying out elk shift to the summer annuals (*Eriogonum*, *Gila*, *Melilotus*, *Helianthus*, etc.), perennial forbs (*Glycyrrhiza*, *Lepidota*, etc.), and some grasses (*Bromus*, *Echinochloa*, *Poa*, *Agropyon*, *Elymus*, *Horleum*, and *Carex*). When the herbaceous plants begin to dry out in the fall there is a gradual

shift toward browse (Artemisia, Erogonum, Carex, Salix, Populus, Robina Pseudo-Acacia, Rosa, Astragalus, Asclepias, and Equistetum) which hold nutrients better. The winter diet is supplemented with dried grasses.

In the Owens Valley, California, each of the five elk herds has its own home range. Each herd's home range is divided into seasonally used or preferred habitats. Areas used in the summer are accessible in the winter as well, but little used. There are seasonal movements to habitats with abundant foods, although there is great variation in the timing and location of foods year to year. Elk also "establish a daily pattern suitable for exploiting the local food and water resources" (McCullough, 1971:49). They have alternating periods of rest and feeding averaging two hours each. This rhythm is maintained around the clock except for a noticeable decline in activity during midday. If the herd is large various groups will not be synchronized, thus some will be feeding while others are resting.

Elk are gregarious herbivores which like the bison have two types of herds throughout most of the year (McCullough, 1971:52-53). The basic unit is a cow group which consists of cows, calves, and young males. Toward the beginning of rut a number of cow groups amalgamate. Large herds are the rule until mid-rut when the large herds break down into smaller units. During the latter phase of rut the herds increase in size again. After rut, bull groups reform and the average size of cow herds decrease. Small herds are common throughout winter, and the spring calving period until calves are strong enough to follow the large rutting herds. As the rut begins bull groups disband. A single dominant bull joins a cow herd and repells the challenges of bachelor bulls which loiter near cow herds during rut.

Historical records of elk suggest they were never as numerous as bison, deer, or antelope. In the late spring of 1851 Marcy never recorded an actual sighting, but he did see elk tracks along the North Fork of Red River, Oklahoma near Quartz Mountain (U.S. War Dept. 1937) His Indian guide reported that elk were more abundant five years before. In the winter of 1868, Keim sighted a number of single elk and herds while in the Wichita Mountains (1970). It is interesting that there has been no early historical sighting of elk in the grasslands, instead all have been in the Wichita Mountains or nearby.

Elk Procurement

Historic records of elk procurement in the Southern Plains are virtually lacking. Wallace and Hoebel, (1952:67) briefly mention that

the Comanche did in fact hunt elk in the wooded valleys of their territory. Captain Marcy's journal indicates that Indian elk hunting near the Wichita Mountains by 1851 had been intensive enough to greatly reduce the elk population (U.S. War Dept. 1937:35). The Cheyennes told Grinnell (1972a:273-274) that when they lived in the Eastern Woodlands they hunted elk by surrounding and pounding, or by setting snares in trails. The Araphoes drove elk over cliffs very near the place where the Cheyenne drove buffalo over cliffs (Grinnell, 1972a:276).

It is quite probable that elk were also hunted by the various small group or individual hunting techniques as well (see deer and bison procurement). Weapons for procuring elk would have been identical to those used for other animals except for the addition of snares.

Whitetail Deer (Odocoileus virginianus)

The mean adult weight of whitetail deer is from 70 to 200 pounds. The favored habitat is brushy or wooded country. Within this environ the heaviest use occurs in edge situations with good cover and the greatest amount of available food such as low shrubs and bushes.

Whitetail deer are grazers and browsers, eating green sprouts, seedlings of trees and shrubs, weeds, and some grasses. There are obvious seasonal variations defined by availability of foods such as sprouts in the spring and mast in the fall and winter (Davis, 1960:232). During the winter, stomach contents from five deer from the Wichita Mountains have been analyzed (Halloran and Glass, 1959:367). One deer stomach contained 100% acorns, three others had high percentages of sumac and oak. The last deer stomach had mostly Smilax leaves, elm leaves and buds, grasses, and juniper twigs, plus small amounts of blackjack oak, pecan, and coralberry leaves.

Daily movements seem to be controlled by feeding and rest periods. The location of feed and rest areas varies within a deer's territory, and is a function of the spatial distribution of seasonally available foods, daily temperatures, and weather conditions. Deer have two feeding and rest periods. The first feeding period begins before sunrise and often occurs in an open area. As the sun rises, deer begin feeding near the edges of woods or brushy areas. Generally within a few hours after dawn deer have moved to a well covered rest area. Deer remain at their rest areas until late afternoon when they begin feeding in edge situations. After sunset deer begin feeding in open areas and continue until midnight. At this point deer then move back to their rest areas and remain until the morning feeding period begins. In their movements between feed and rest areas standardized trails are used.

Whitetail deer have matriarchal family units composed of a doe, fawn(s), and possibly a young buck. They are not gregarious animals but are found in small groups are individually scattered throughout their habitat. The rutting season in the late fall (November) marks an increase in diurnal activity and group size, allowing more productive hunting at this time. Fawning season is in late May and June. Both March (U.S. War Dept., 1937) and Keim (1970) strongly suggest that as Keim states (1970:233) there are herds of deer "in every ravine" as well as the upland forests throughout the Southwest Oklahoma region.

Deer Procurement

Very little has been written about aboriginal deer hunting in the Southern Plains. Deer do not seem to have made up a substantial portion of the Plains tribes diet (Newcomb, 1961; Wallace and Hoebel, 1952; Grinnell, 1972a). In fact, John Sibley (1832:723) wrote of the Wichitas that "their meat is principally buffalo; they seldom kill deer, though they are so plentiful they come into their villages and about their houses like a domestic animal."

The Cheyenne hunted deer with small groups of hunters or individually (Grinnell, 1972a), but remembered when they surrounded or drove deer into enclosures in the Eastern Woodlands. Gregg (1954: 417) in a discussion of Indian dietary preferences on the Plains notes that "deer, as difficult to take in the chase [as antelope], is less easily entrapped." Although not in the Southern Plains proper, Nuñez Cabeza de Vaca in 1530 noted while in central Texas that,

> These Indians are so accustomed to running, that without rest or fatigue they follow a deer from morning to night. In this way they kill many. They pursue them until tired down, and sometimes overtake them in the race. . . . They are accustomed also to kill deer by encircling them with fires (Nuñez, 1966;104, 106).

Modern hunters usually hunt deer by three basic techniques; runway hunting (i.e. ambushing deer that walk along trails), stalking, or driving (Ruhl, 1956). The drive is the only cooperative technique. These methods are used more often in the Eastern Woodlands than the Plains. In the West a common technique is to hunt singularly or in a small group while conducting an informal drive in an attempt to "scare up" a deer from a wooded arroyo or thicket.

Pronghorn (Antilocapra americana)

The mean adult weight of antelope varies from 90 to 125 pounds. They inhabit dry open grasslands and their range extends into western Oklahoma. This boundary is apparently controlled by precipitation during the fawning period and predation.

Pronghorns in the Texas Trans Pecos eat mostly forbs, browse, and grasses during the summer. During the winter, pronghorns eat more browse and less forbs and grasses (Davis, 1960:224). Antelope in the Wichita Mountains Wildlife Refuge during the winter ate black-jack oak, red cedar, buttonbush, 24 different forbs, and 5 types of grass (Halloran and Glass, 1959:368). Very little is known about pronghorn seasonal or daily movements, except what can be deduced from [illegible]

Both of the above tribes as well as the Lipan Apache and Cheyenne (Newcomb, 1961; Grinnell, 1972a) took antelope by either the surround, or the pound. After the antelope were pounded or surrounded a variety of methods were used to kill them. Antelope were caught by hand or roped, and then clubbed to death by the Kiowa, Kiowa-Apache, and Cheyenne. If any antelope escaped, they would then be killed with bow and arrows or guns. The Lipan Apaches, however, did use bow and arrows within the actual surround.

The antelope surrounding and pounding techniques were highly structured by ritual behavior among virtually all groups (Newcomb, 1961; Wallace and Hoebel, 1952; Grinnell, 1972). The Cheyenne believed that antelope were "called" into the pounds by special individuals of their tribe (Grinnell, 1972a:289).

The Kiowa, Kiowa-Apache, and Cheyenne also acquired antelope by digging pits in antelope trails which lead from grazing areas to shelter areas. Herman Lehmann, a white Apache captive, hunted antelope in blinds and witnessed another Indian stalk antelope while concealed under an antelope skin. Unfortunately this Indian was not very successful as he was mistaken for an antelope by another Indian and killed (Lehmann, 1927).

Small Game

Black Tailed Prairie Dog (Cynomys lucovicianus)

Prairie dogs average two or three pounds for adults. They are burrowing ground squirrels that live in colonies numbering from a few individuals to thousands of animals. These "towns" are usually situated on open grasslands away from thick brush or tall grass.

Prairie dogs eat low growing weeds and grasses, and also small animals such as worms. During the spring, summer and fall they build up bodily fat reserves to help them survive winter.

Prairie dogs are diurnal but most active in the morning and evening. They never venture far from the town using their burrows as vantage points and retreats from danger.

In March and April pups are born in litters of four to five individuals.

Beaver (*Castor canadensis*)

The average weight of adult beaver is 40 pounds but weights up to 60 pounds have been recorded. Beaver occupy streams or rivers and are notorious for modifying their environment to suit their needs by building dams. In the southern areas of North America, they usually live in burrows in stream or lake banks.

Beaver's mainstay is the inner bark of trees. The preferred species vary considerably but seems to depend on availability. During the growing season a number of aquatic plants and sedges are eaten such as bermuda and beard grass, ragweed, and yellow water lily.

Beavers are thought to be monagamous. The breeding season is in January and February with a gestation period of 4 months. Usually only one litter is produced per year, but occasionally a second litter is born in August or September.

Fox Squirrels (*Sciurus niger*)

The average weight of adult fox squirrels ranges from 1.3 to 2.8 pounds. Squirrels are restricted to river valleys with mixed hardwood forest composed of pecans, walnuts, oaks or others. Good squirrel habitat can support one squirrel per two acres.

During fall and winter acorns are the most important food source. In the spring and summer foods include insects, green shoots, fruits, seeds, and last season's mast. Caches of nuts are hidden underground for winter use. Fox squirrels may range over 40 acres during a year and at least 10 acres in a season (MacClintock, 1970:132).

The fox squirrel mates from January to February but may mate again in May and June. The gestation period is six to seven weeks (Davis, 1960:141).

Cottontail Rabbit (*Sylvilagus auduboni, Sylvilagus floridanus*)

Adult cottontail weigh from 1.5 to 3.0 pounds. They eat a variety of plant foods including grasses, weeds, shrub twigs and bark, green mesquite pods, and cacti. The two species combined are found in a variety of habitats which include grasslands, brushy areas and thickets, and areas almost denuded of vegetation such as prairie dog towns.

Cottontails are most active at night and they "seldom range more than 400 yards from their preferred thickets" (Davis, 1960:216). Two or more litters may be born a year and there is a continuous breeding season. The gestation period is approximately 26 to 27 days.

Jackrabbit (Lepus californicus)

Adult jackrabbits weigh from 4 to 8 pounds. They inhabit the more open grassland and scrub vegetation regions. Favored foods include numerous grasses and forbes, mesquite, sagebrush, and cacti. In West Texas jackrabbit have been found in densities equalling 400 per square mile (Davis, 1960:212).

The breeding season spans from December to September and litters range from 2 to 6 individuals. The gestation period takes 41 to 47 days (Davis, 1960:213).

Small Game Procurement

Small animals seem to have been eaten by most groups in the Southern Plains but in varying amounts by each tribe.

In hard times the Comanche were known to eat rabbits, terrapins, turtles, snakes, skunks, rats, and lizards, but only if no other foods were available (Wallace and Hoebel,1952:70). The Kiowa ate small animals but these resources did not constitute an important part of the diet (Newcomb, 1961:197). The Lipan Apache ate javelina, rats and other small animals. Rats were roasted whole without being skinned, (Newcomb, 1961:113). During the communal hunts of antelope or bison many smaller animals were also captured (Newcomb, 1961:167; Grinnell, 1972a:188).

Young Cheyenne boys learned the art of hunting by hunting small birds or animals often with a small group cooperative technique (Grinnell, 1972a:102). This was a very serious and integral aspect of a boy's education. As the boys became older and more adept they hunted larger and larger prey. The meat was not wasted but was contributed to the food stock of the family.

Turtles were also eaten by the Cheyenne (Grinnell, 1972a:307-308). They were captured by individuals or at times by a group of men, women, and children by the surround method applied to an aquatic situation.

The Cheyenne also ate beaver. They trained dogs to enter a beaver's hole, and aggravate the beaver until he chased the dog out to the entrance where the beaver was then clubbed or shot with arrows.

Summary and Conclusions

At least fifteen species of animals and 80 species of plants in the Southern Plains were known to have contributed to the diet of the various Indian groups. Although no one group utilized all the species, each group's choice of species still constitutes a remarkably varied diet. Except for domesticates, all major food types (mobile and non-mobile: animals, nuts, fruits, roots) were used by the groups in the Southern Plains.

A general picture emerges in terms of the seasonal procurement of resources:

The early spring is perhaps the hardest season. The plant resources collected and preserved in other seasons would most likely have been eaten. People would have to depend on animals almost entirely as the few roots available throughout the year are never very abundant. One might expect procurement activities to focus more heavily on less mobile, predictable animal species, and a slight increase on the hunting of large, high yield animals. Later in the spring the calving or fawning seasons would produce easily hunted or scavenged infants even though the herds are still small and dispersed.

During the late spring and summer edible fruit and root bearing species begin to offer their yield and the collection of these foods would greatly boost the nutritional variety of the diet. After the calving season, bison and elk herds begin to coalesce because of breeding activities. While the herds are large they offer the greatest potential yield and may be most efficiently hunted by a communal hunting technique.

In the fall many of the fruits and roots disappear, but new fruits become ripe and all of the nuts ripen. In a relative sense the bison and elk herds become smaller while the deer become more active during the day and group size increases, as do antelope herds.

During the summer and fall when most plant foods are available, surplus food could be (and ethnographically was) dried or somehow prepared for use during the winter. Whenever enough surplus meat was available it was also preserved.

Except for a few roots almost all plant foods.had disappeared by winter. At this time stored plant foods and newly acquired meat or preserved meat would have to make up the menu. As with early spring, one would again expect an increased emphasis on animal foods.

Thus it appears that resources vary in terms of their location, time of availability, and quanity of edible yield. Variations in space and time can be viewed using the concept of allopatric and sympatric species that may or may not be available during the same season. These variations produce four different situations which could possibly produce a conflict for the time and location of an individual group.

SPECIES RELATIONSHIPS

		ALLOPATRIC SPECIES	SYMPATRIC SPECIES
SEASONAL AVAILABILITY	DIFFERENT	No Conflict Seasonal transhumance implied for exploitation	No Conflict Multiseasonal occupation of area implied
	SAME	Spatial and Temporal Conflict Task group differentiation and segregation implied by simultaneous exploitation	Potential Conflict Task group size and composition may prohibit simultaneous exploitation

The scheduling of procurement activities (Flannery 1968:75) is one method a group may use to alleviate a conflict between competing resources. Another method is by allowing different groups to perform seperate tasks. These groups are usually defined along sex boundaries, but may also be defined by age or kinship. The division of labor integrated with scheduling can solve most conflicts between competing resources.

In Southwest Oklahoma in the late spring and summer, there are at least 71 different edible species available, but in the winter and

early spring only 29 may be exploited. The number of choices and thus the number of conflicts would be reduced in the winter with more conflicts in the fall, the greatest in the summer. The situation is made a great deal more complex when one considers the year round conflicts between resource procurement activities and non resource procurement activities, such as the tool, clothing, and shelter production and maintenance activities, or social and religious activities. Any detailed discussions of these types of scheduling conflicts are beyond the scope of this essay.

Obviously the amount of edible yield each resource offers would be an important consideration in terms of scheduling economic activities.

All other factors being equal, increased availability and productivity of a resource would be reflected in its increased exploitation. Thus it would logically follow that a group would disperse itself and its work forces in such a manner that food resources would be exploited with the minimal expenditures of energy. Such an assumption is commonly encountered at some level in many investigations concerned with such aspects of prehistoric economies. Unfortunately, the application of pure economic principles to such analyses are controversial and assumptions of maximization of yield should not unqualifiably be made in the analysis of hunting and gathering economies. Such problems are a central issue to approaches such as Jochim's (1976). The ethnographic record presented here bears this out, since most of the groups discussed had distinct dietary preferences or had social institutions which mandated exploitation of certain resources over others or structured the labor force in such a way that exploitation of certain resources were not exploited efficiently. It is from these points of view that the ethnographic record becomes a useful research tool to be analyzed along with some theoretical approaches to the study of

Chapter 4

GEOLOGY OF ARCHAEOLOGIC SITES AT FORT SILL, OKLAHOMA

by
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Introduction

During March, 1977, the writer examined the late Quaternary sediments and geomorphology of several stream valleys at Fort Sill in conjunction with archaeologic surveys and excavations by the

Gabbro Group in the Tillman graywackes and extrusion of the Navajoe Mountain basalts on top of the Tillman. Next, the first extrusive stage of the Carleton rhyolite occurred, accompanied by uplifting and faulting. The succeeding second extrusive stage of the Carleton

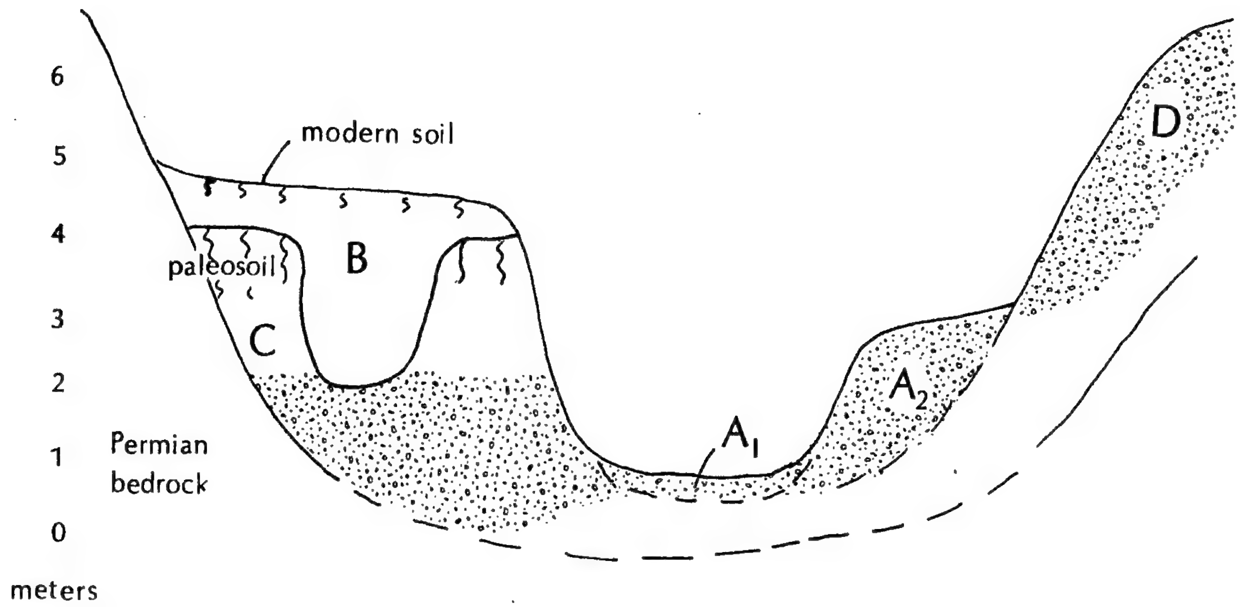


Figure 4-1. Composite cross section of Post Oak Creek valley.

The four meter terrace surface is the most widespread flood-plain deposit in the valley. It is this surface on which most of the archaeologic sites occur. The sediments that make up the terrace represent two alluvial units of different ages. The older unit is characteristically a yellow-reddish mottled gray sandy clay with a paleosol at the top. The paleosol contains a 60-cm zone of calcium carbonate pellets (up to 15 mm dia.) and thin coatings on coarse angular sand grains. The younger alluvium is a noncalcareous grayish brown sandy clay. It is not mottled such as the older alluvium nor is a paleosol developed in it. A thin layer of the younger alluvium may overlie the older unit or it may fill former channels that were cut into the older. In the downstream area of Post Oak valley, the younger alluvium forms a low terrace (about two meters height above the stream channel). The older alluvium is occasionally exposed beneath the younger in stream banks.

The two meter terrace surface occurs discontinuously along the present stream channel in the upstream part of Post Oak Creek.

Downstream the two meter granite gravel terrace is not present although a 0.5 meter terrace adjacent some parts of the modern channel may be time-equivalent. The downstream channel of Post Oak Creek is choked with sediment, resulting in the absence of cut banks.

Artifacts at archaeologic site Cm-240 occur in the calcareous paleosol and mottled yellow-reddish sandy clay of the older alluvium described above and underlying the four meter terrace surface. Nearby site Cm-241 occurs in geologically younger sediments, probably equivalent to the younger unit (unit B) of the four meter terrace

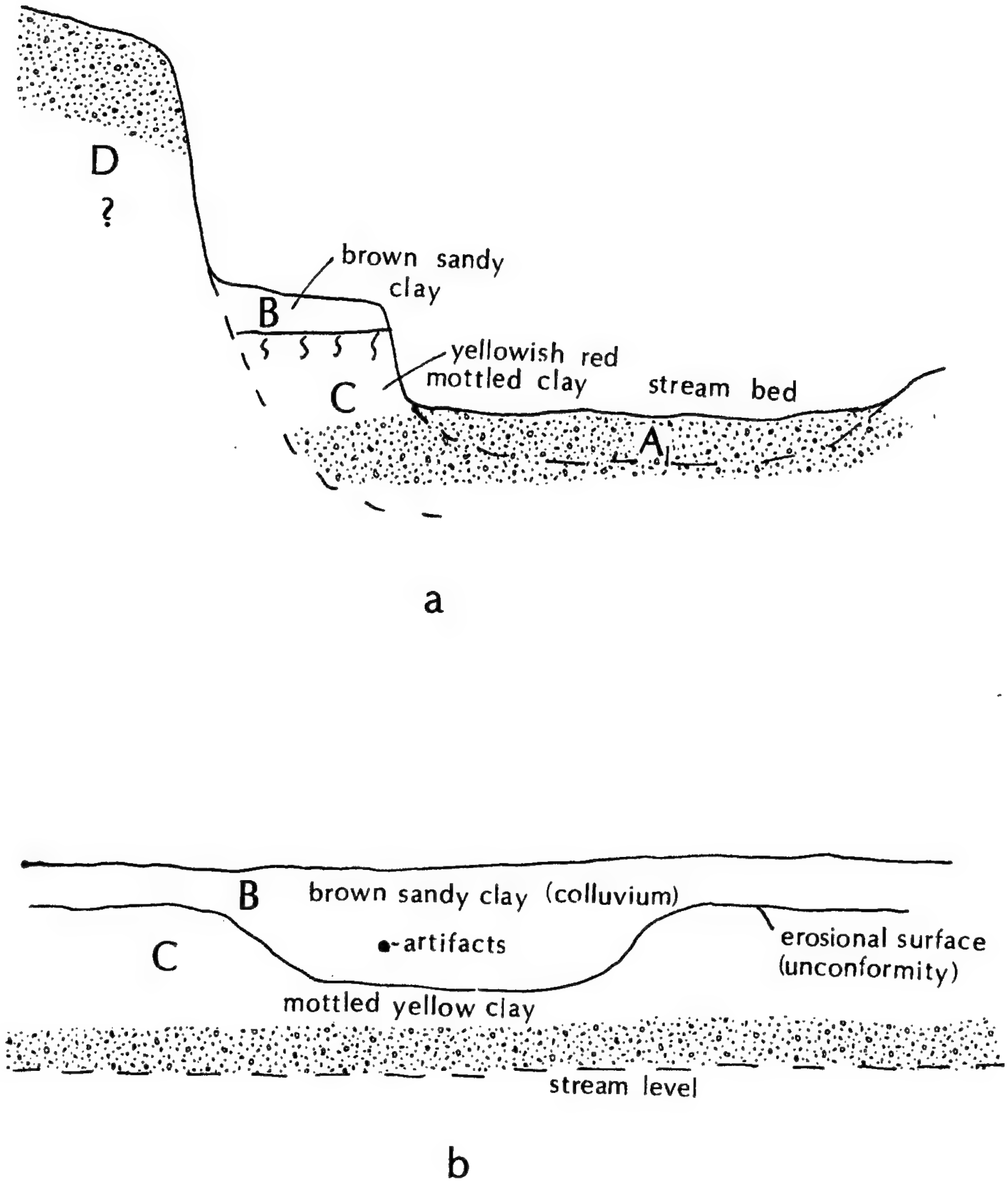


Figure 4-2. Stratigraphic sections along West Cache Creek.
a – composite cross section of West Cache Creek;
b – diagrammatic section of site Cm-275.

alluvial paleosol that has been buried by one to two meters of brown clay. The paleosol and associated sediments do not resemble the mottled clay-paleosol sequence exposed elsewhere on West Cache or Post Oak creeks.

Crater Creek. Alluvial deposits along the upper part of Crater Creek are sparse. A low elevation terrace deposit of mottled yellow gravelly sandy clay overlain by a less indurated brown sandy clay occurs in the middle and lower parts of Crater valley. These deposits probably correlate with those of the four meter terrace alluvium and the two meter terrace alluvium of Post Oak and West Cache, respectively.

The archaeologic skeletal remains (Cm-323) on Crater Creek occur in the brown clay that overlies the mottled clay unit. Thus, the remains correlate in general with the unit B brown clay that overlies the paleosol on Post Oak Creek and West Cache Creek.

Blue Beaver Creek. The upper part of Blue Beaver Creek valley around Ketch Lake does not contain alluvial deposits although scattered rhyolite cobbles along the stream are indicative of strong runoff, either prehistoric or modern. South of Signal Mountain Road, which includes most of the stream valley in Fort Sill, the valley sediments are disturbed by military training activities. The few undisturbed exposures [illegible]

the age of the underlying sediment is probably near equivalent to that of alluvial unit B. The artifacts, accordingly, are young, too.

Artifacts of site Cm-65 occur on the eroded colluvial surface of a sloping surface six to eight meters above the present stream level. The colluvium is a reddish clayey gravel and may represent a residual lag from the Post Oak Conglomerate (Permian) or a Pleistocene gravel. Although the sediment is colluvial and eroded, the artifacts could predate the formation of the unit C paleosol elsewhere in the area. The red clay is an unusual sediment type in the Blue Beaver Creek valley and may be early Holocene in age. However, precise geologic dating is not possible owing to the absence of any clear stratigraphic relationship of the red clay with the Quaternary alluvium.

Medicine Creek. Two terrace surfaces are present along most of the narrow stream valley (Figure 4-3). The lower terrace varies from 1.3 to 2.7 meters above the modern stream channel. The terrace alluvium is largely brown sandy clay to light brown unconsolidated clayey sand. The upper terrace surface is 3.5 to 6.0 meters above the modern stream. The sediment beneath this higher terrace varies from a brown sandy clay with little gravel to a light brown sandy clay to a brown sandy gravel. A comparatively thick (60 cm) soil, probably still forming today occurs at the top of the high terrace. A paleosol was not seen in either high or low terrace alluvium. Because of the absence of a paleosol, the lack of sediment mottling, and the lack of sediment induration, the high terrace alluvium is thought to be of comparatively young age, possibly time-

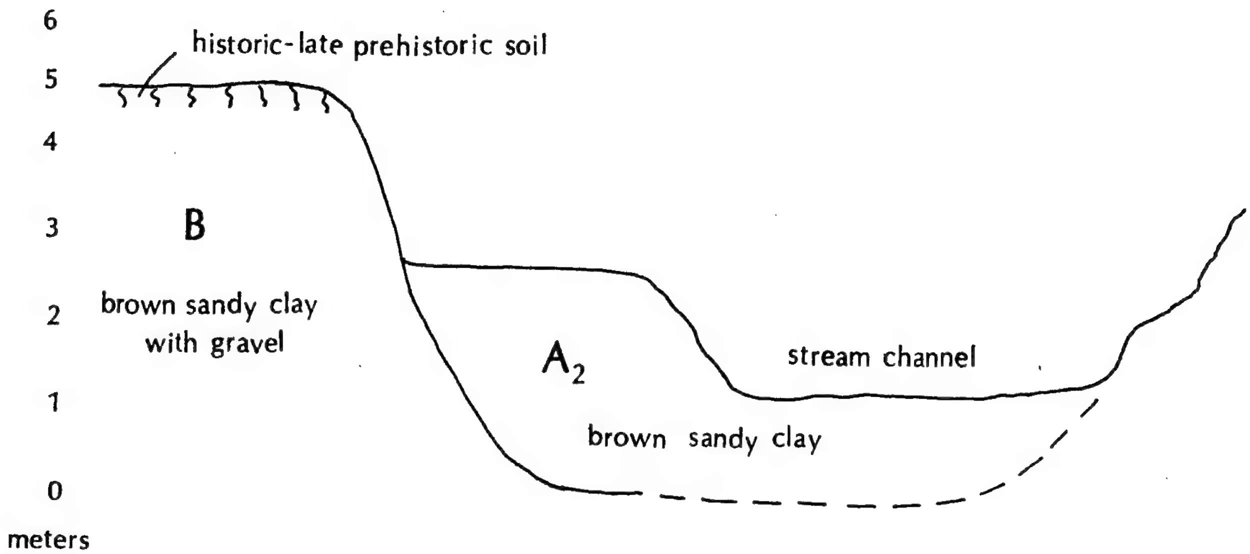
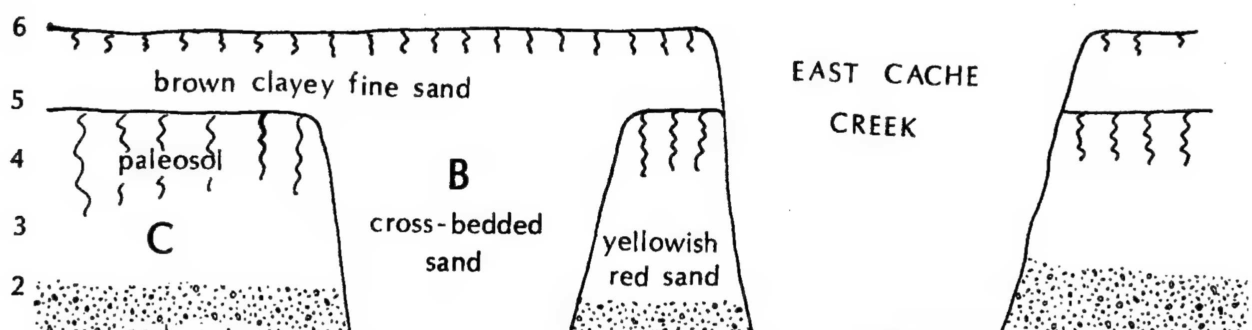


Figure 4-3. Composite cross section of Medicine Creek.



the top. Calcium carbonate has accumulated in the lower part of the paleosol as discontinuous films on the surface of peds and along rootlet tubes. The carbonate content is greater here than with the paleosols on Post Oak and West Cache creeks. Calcium carbonate nodules 1.0 cm in diameter occur below the paleosol at 360 cm depth and, at 500 to 600 cm depth, carbonate concretions up to two cm thick occur in continuous lenses. The large amount of carbonate compared with that in the other Fort Sill stream deposits to the west may be explained by the presence of Early Paleozoic limestones in the drainage basin of East Cache Creek and the absence of carbonate sources in the drainages of the other streams. The East Cache paleosol extends continuously for at least several miles up and down the valley, including the Gore Pit area where it overlies that Archaic site.

The paleosol is in places eroded by a channel that trenched the floodplain (of that time) to a depth of over five meters; the base of the channel fill extends beyond the present stream water level and is not exposed. Crossbedded brown clayey sand fills the ancient channel and covers the uneroded paleosol-capped alluvium by about one meter depth. A modern soil is forming on the brown sand surface, and includes a weak film of calcium carbonate accumulation in clay at 70-90 cm below the present surface.

Artifacts at Pig Farm Crossing archaeologic site occur in situ in the paleosol. Radiocarbon dates from the archaeologic horizons will provide a chronology for the period of formation of the widely occurring paleosol. At present there are no clear correlations of the paleosol with other paleosols in the Southern Plains.

Summary and Conclusions

The stream valleys at Fort Sill contain, collectively, three major deposits: (unit C) a mottled clay or sandy clay capped by a paleosol with a carbonate horizon, (unit B) a brown clay or sandy clay which overlies the unit C paleosol and fills an old [illegible]

Geologic Units	Post Oak Creek	West Cache Creek	Crater Creek	Blue Beaver Creek	Medicine Creek	East Cache Creek	
A_1	modern channel gravel	sandy gravel				gravel bars in channel	modern channel sediments HISTORIC
A_2	2 m terrace				brown-sandy clay low terrace		early historic channel sediments
B	4 m terrace	2 m terrace brown sandy clay colluvium & alluvium	brown sandy clay	rhyolite gravel	high terrace brown sandy clay, gravel	channel fill brown clayey sand	Cm-68, Cm-241 Cm-246, Cm-323 LATE HOLOCENE Pig Farm Crossing Cm-240
C	paleosol mottled yellow-red gray clay	paleosol mottled yellow-red clay	yellow mottled clay, gravelly			paleosol yellow-red sandy clay carbonate concretions at 4+ m depth	Pig Farm Crossing Cm-240 Gore Pit Site EARLY HOLOCENE
D	6 m terrace granite gravel	6 m terrace granite-rhyolite gravel				possible occurrence on hill-slopes above broad terrace	LATE PLEISTOCENE

Note: Vertical hatching indicates absence of sediments; wavy horizontal line indicates erosional unconformity.

Figure 4-5. Summary chart-- Fort Sill Quaternary geology.

[illegible]

APPENDIX

Selected Stratigraphic Sections from Quaternary Alluvium.

Post Oak Creek Section. (NE1/4 NE1/4 NE1/4 SE1/4 sec. 35, T 3 N, R 15 W; 2,400 feet N of south section line 10 m west of Quanah Range boundary road, left bank.)

Unit B	clay, brown, silty	0 to 20 cm depth
Unit C	clay, gray, yellow-reddish mottled; occasional granitic sand lenses, esp. lower 50 cm; calcium carbonate nodules up to 15 mm dia. restricted to upper 60 cm of gray clay but does not occur as a layer, rather as isolated concretions; probably partly leached paleosol.	20 to 110 cm
	clay, gray, sandy grades to sandy clayey gravel in lower 80 cm; gray clay with yellow-reddish mottling; yellow staining of gravel at 200 cm depth.	110 to 220 cm
	gravel, sandy, with some gray clay; gravels up to 25 cm dia.	220 to 380+ cm (to stream level)

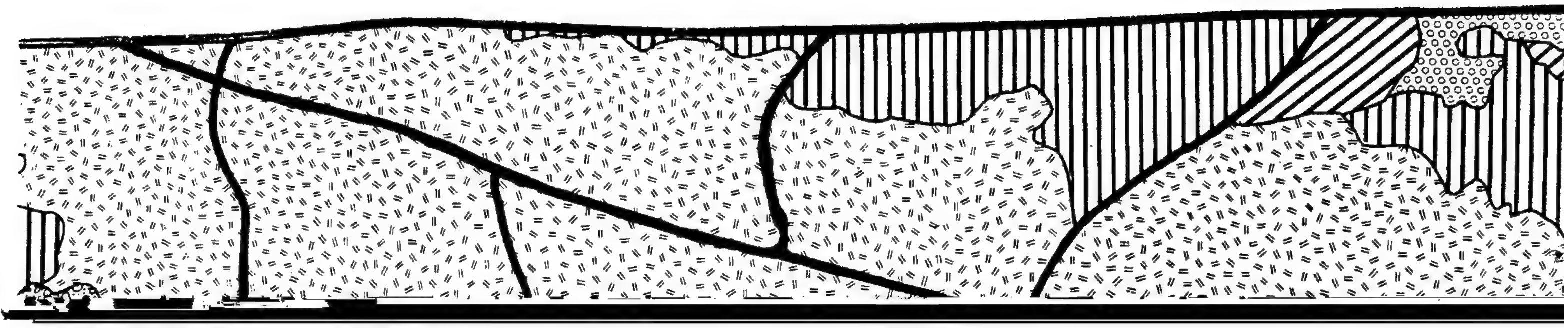
East Cache Creek Section. (Fort Sill 6000 area, about 100 meters downstream from junction of sewage ditch with East Cache about 430 m SSE of Hoyle Bridge, right bank.)

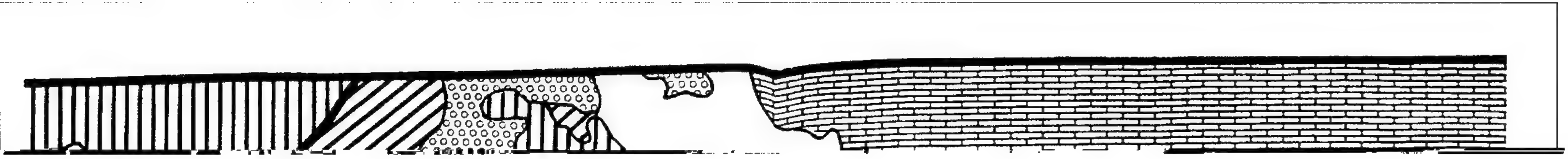
Unit B	soil, fine sand, light grayish brown, clayey; rodent burrows; modern soil.	0 to 10 cm depth
	Fine and very fine sand, brown (7.5 YR5/4, dry), silty, massive at 10 to 50 cm depth; clay lenses at 50 to 90 cm depth; microcrossbedding in fine sand interrupted by three mm dia. clay-filled burrows; all of bed calcareous; very thin film of calcium carbonate in cracks in clay, becoming more abundant at 70 to 90 cm depth.	10 to 90 cm

Unit C	paleosol; clay, dark brown (7.5 YR4/2, dry), silty, massive, hard; discontinuous thin films of calcium carbonate along root tubes structure changes from massive to blocky at base and grades to underlying find sand.	90 to 150 cm
	fine sand, dark brown (7.5 YR4/2, dry), clayey, blocky, not hard, no bedding features; calcium carbonate film in rootlet tubes, lower part of bed less calcareous, matrix itself noncalcareous; color grades to yellowish red (5 YR5/6, dry), at base; sharp contact with underlying bed.	150 to 240 cm
	paleosol; clay reddish brown (5 YR5/4, dry), silty; blocky to prismatic; calcium carbonate film in rootlet tubes and forms continuous coating on some ped surfaces, carbonate nodules 1.0 cm dia. appear at 360 cm depth and increase in abundance to base of clay bed.	240 to 430 cm
	fine sand, yellowish red (5 YR5/8, dry), massive to laminated, irregular bedding; two cm thick layers of calcium carbonate nodules some nodules are cemented together forming continuous beds; occasional one cm thick clay layers; lower 90 cm covered.	430 to 610 cm (to stream level)

The dark brown fine sand bed (150 to 240 cm depth) thins laterally and pinches out about 100 meters downstream from the above measured section, resulting in the "merging" of the two paleosols described above. This sand bed, wedged between the two paleosols, is interpreted as a unit of sediment deposited on an actively forming soil (paleosol, 240 to 430 cm depth), terminating soil development at that surface. Soil formation continued on the newly deposited sand resulting in two soils at that locality although elsewhere on the floodplain the episode of soil development was not interrupted by sedimentation. The two paleosols described above developed concurrently

with the formation of one paleosol elsewhere along East Cache Creek. Based on the thickness and amount of carbonate accumulation of the two paleosols, the sand wedge was probably deposited at a time intermediate during the last half of the total episode of soil genesis.





Chapter 5

TOPOGRAPHY, HYDROGRAPHY AND SOILS OF FORT SILL

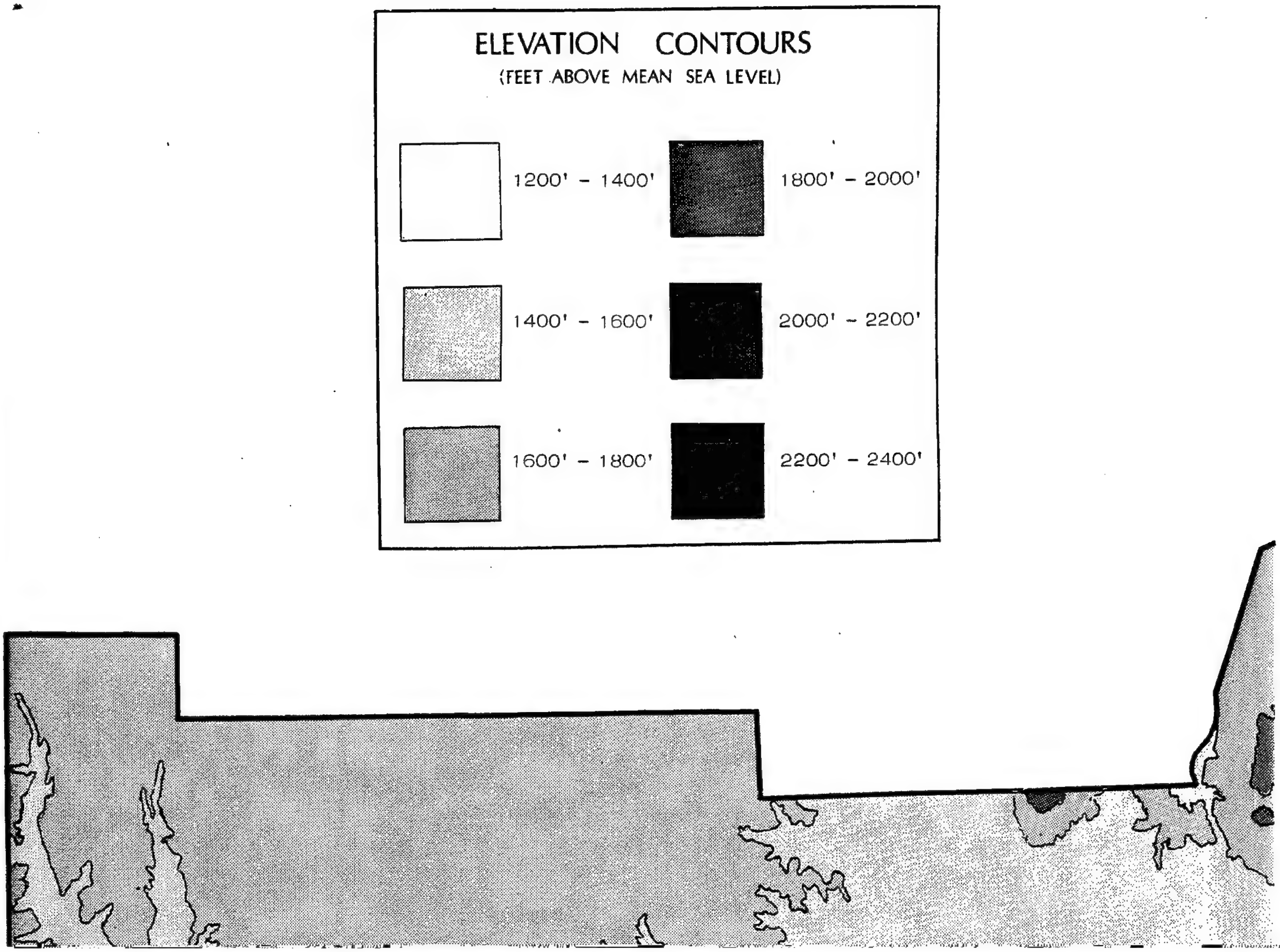
by
C. Reid Ferring

Introduction

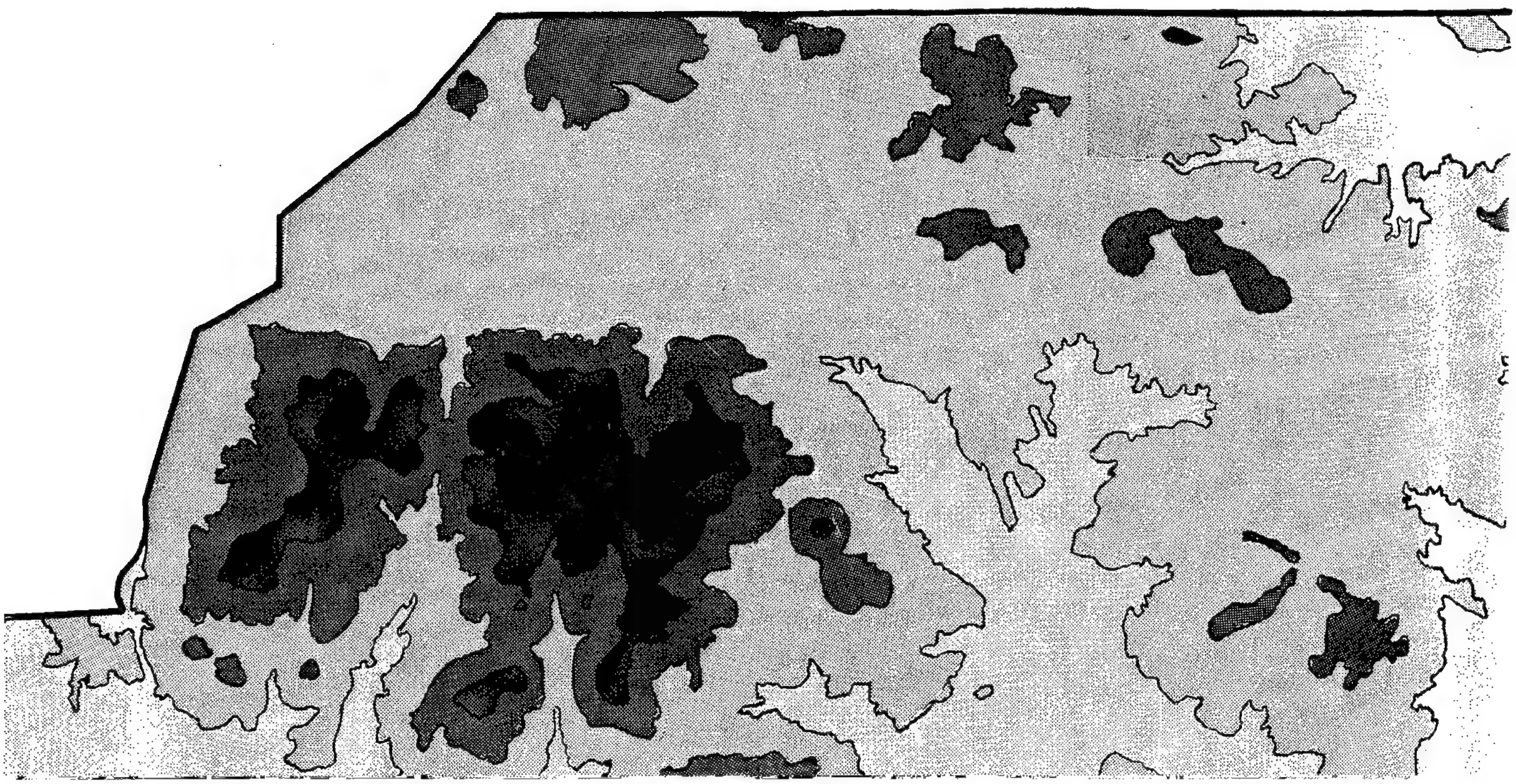
Descriptions of the topography, hydrography and soils of Fort Sill are presented here to round out the description of the study area. Interrelationships between these factors and those described in chapters dealing with the vegetation and faunas are important ones. The geology for the Fort Sill area (Hall, this volume) is all important with respect to the patterning of both physical and biotic components of the Fort Sill landscape. Reference to Hall's discussion as well as the geological map of Fort Sill (Map 1) should illustrate this point.

Topography

The topography of the Fort Sill Reservation follows closely the geologic composition of the area (Maps 1, 2). The granite, rhyolite


ELEVATION CONTOURS
(FEET ABOVE MEAN SEA LEVEL)
1200' - 1400'
1800' - 2000'
1400' - 1600'
2000' - 2200'
1600' - 1800'
2200' - 2400'

MAP 3



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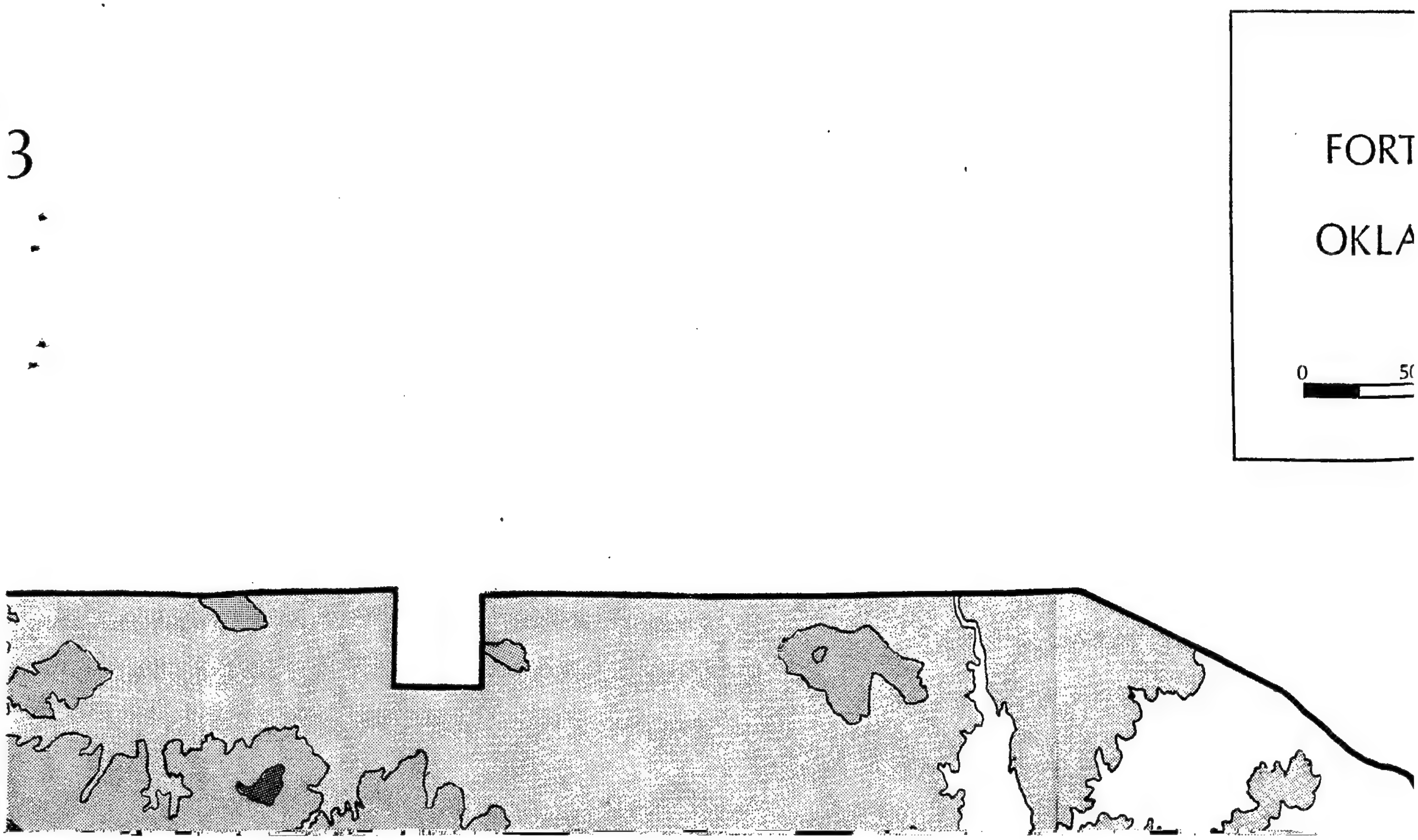

Hydrography

The major streams of Fort Sill are all southerly flowing tributaries of the Red River. All head in the Wichita Mountains with the exception of East Cache Creek. Six of these streams may, except perhaps in drought conditions, be regarded as perennial. From west to east these streams are: Post Oak, West Cache, Crater, Blue Beaver, Medicine and East Cache. The latter is the major drainage in the area, and all of the former streams feed into East Cache Creek before the latter joins the Red River. While surface water is available in these streams at almost all times, it is frequently restricted to the upper reaches of the western streams during much of the year. This is because the springs which feed the streams are mainly located in the hills in which

Konawa soils are deep, very gently sloping to sloping upland soils. They are usually loamy fine sands supporting a vegetation dominated by scrub oak forest. These soils are closely associated with the Windthorst soils.

Windthorst soils are generally gently sloping sandy loams formed on granite outwash over Permian red beds along streams flowing from the Wichita Mountains. The lower portions of these soils consist of massive, noncalcareous mottled grey clay.

Lawton soils are deep, gently sloping and very gently sloping upland soils developed on granite outwash. These deep, loamy soils have granite pebbles and sand throughout their profiles, are well drained and support tall and mid-grasses.

Limestone cobbly soils are strongly sloping to steep soils with

Chapter 6

A BOTANICAL SURVEY OF FORT SILL

by
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Introduction

This botanical survey was undertaken as part of the Fort Sill Archaeological Reconnaissance and was performed between October, 1976 and March, 1977. The goal of the survey was to provide a data base from which the botanical variability at Fort Sill could be described and later utilized for purposes of evaluating possible relationships between archaeologically defined occupations and the local environment. This survey was necessitated in part because of the lack of data bases from which such relationships could be inferred. Previous studies at Fort Sill have been lacking in part because of the difficult access to many portions of the reservation. Prominent studies of the local vegetation may be found in Buck (1964) and Crockett (1964). These two studies were conducted at the Wichita Mountains Wildlife Refuge which is contiguous with and to the north of the Military Reservation. Certain goals of the interdisciplinary reconnaissance, particularly the desire to investigate soil-vegetation relationships limited the specific application of Buck and Crockett's studies to the present one. This is due to the use of a soil survey in the former studies which is incompatible with those available for Fort Sill. Other problems involve the need of drainage-specific descriptions for the present research.

These investigations were focused on three main aspects of the Fort Sill vegetation: the riparian arboreal vegetation, the riparian undergrowth and the non-arboreal vegetation of the non-alluvial soils. A fourth phase of studies, that of the upland wooded areas, had to be abandoned owing to time factors.

Fort Sill consists of an area of approximately 94,000 acres, located in Comanche County, Oklahoma. Included in the reservation area are the southeastern extremities of the Wichita Mountains. These hills and mountains extend mostly into the central portion of the reservation (Map 3). The eastern ranges, i.e. those east of East Cache Creek, are prairies and are free from the topographic

and edaphic influence of the mountains. The southern and western portions of the reservation are strongly influenced by outwash from the mountains but a nonetheless distinct prairie-mountain ecotone may be observed (Figure 6-1). The most salient difference between the east range and the non-mountain areas of the west range is the presence in the latter area of stands of upland post oak-blackjack oak forest. These appear to be related to edaphic factors (Buck, 1964), but verification at Fort Sill could not be attempted.

Average annual precipitation in Comanche County ranges from 27 inches in the western portions of the county to 32.5 inches in the northeastern corner. Records from 1931 to 1960 in the Wichita Mountains Wildlife Refuge indicate an average of 29.19 inches, while records for the same period in Lawton indicate an annual average of 30.18 inches. This precipitation is distributed seasonally as follows: 34% spring, 27% summer, 24% fall and 15% winter. Comanche County has an average annual temperature of 62.7°F. The monthly averages range from 40.7°F in January to 83.7°F in August. The average daily variation in temperature of 25.9°F emphasizes the rapid changes in temperature, humidity, cloudiness, wind and precipitation which the area is noted for.

Methodology

This survey consisted of three separate but complementary phases designed to provide data on the botanical variability of the riparian and non-riparian areas of the reservation. Distinct techniques were employed in each phase of this research. Overall, however, the goal was to provide quantified information which could be used in present and future analyses dealing with Fort Sill on both a spatial and aspatial level. The need for the former level of analysis stems from the archaeologists desire to ask questions related to the specific environmental setting of a given archaeological site, while the latter aspects of analysis would most likely be encountered when regional or extra-regional considerations were being entertained. The diversity of Fort Sill, as exemplified by its geology, topography, hydrography and soils posed similar sampling problems to this survey as it did to the archaeological reconnaissance (Hackenberger, this volume). Additional sampling problems revolved about logistical factors. The main result of these impediments was the incomplete undergrowth and upland surveys and the impossibility of collecting density information. On the other hand a vast amount of primary data has been accumulated which can serve present and future investigations.

The stream forests were surveyed along ten of the major streams on the reservation. These streams were selected owing to their geographic distributions and size (Map 5). In general these streams run north-south through the reservation, with most having their headwaters to the north of the reservation. The ten streams surveyed and their length within the reservation boundary are as follows:

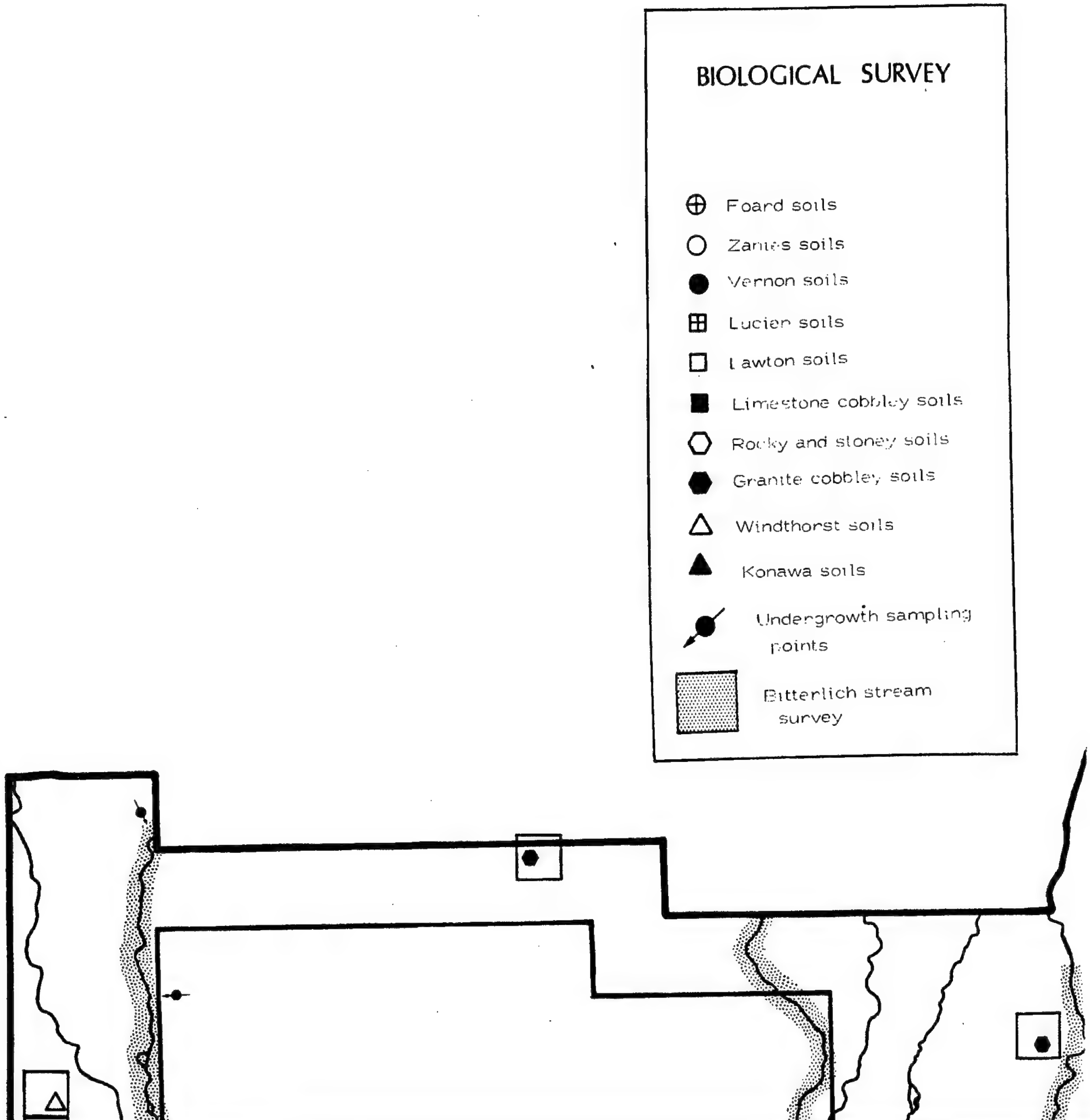
East Cache	13.5 km
Frisco	2.9 km
Beef	5.5 km
Sitting Bear	2.1 km
Medicine	13.5 km
Ketch	4.2 km
Blue Beaver	13.3 km
Crater	4.3 km
West Cache	5.5 km
Post Oak	8.3 km

Each of these streams was systematically sampled, with each of the sample plots being covered by the Bitterlich method (Phillips, 1959). Sample plots were selected at uniform intervals down the length of the stream course. Initially, 50 sample plots per stream were planned and implemented. Subsequent tests of homogeneity indicated that even on the longest streams only 35 sample plots provided the same results. Thus sample plots were reduced to 35 in most cases, and even fewer in others. Each sample site was visited and the Bitterlich counts taken by a team of two. Some alteration in the locations of the sample plots was necessitated by local disturbance or by training activities; major sections of some streams such as Medicine and Sitting Bear were avoided altogether owing to documented alteration of the tree composition in recent times. In general, however, the spacing of the sample plots was achieved as planned.

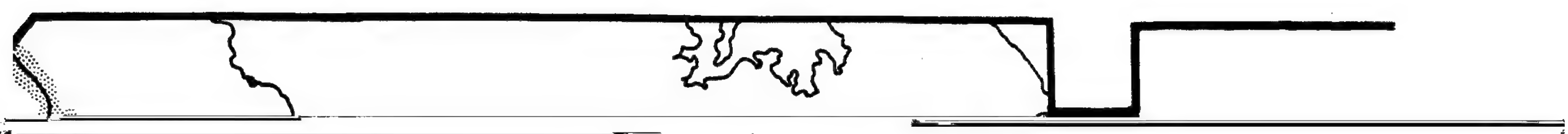
Four indices are used to portray the results by stream of the Bitterlich survey. These indices are defined below:

$$\text{(1) Percent Frequency} = \frac{\text{No. of plots in which species was encountered}}{\text{Total No. of sample plots}} \times 100$$

$$\text{(2) Percent Composition} = \frac{\text{No. of times a species occurred}}{\text{Total No. of trees}} \times 100$$


BIOLOGICAL SURVEY
Foard soils
Zaneis soils
Vernon soils
Lucien soils
Lawton soils
Limestone cobbley soils
Rocky and stoney soils
Granite cobbley soils
Windthorst soils
Konawa soils
Undergrowth sampling points
Bitterlich stream survey

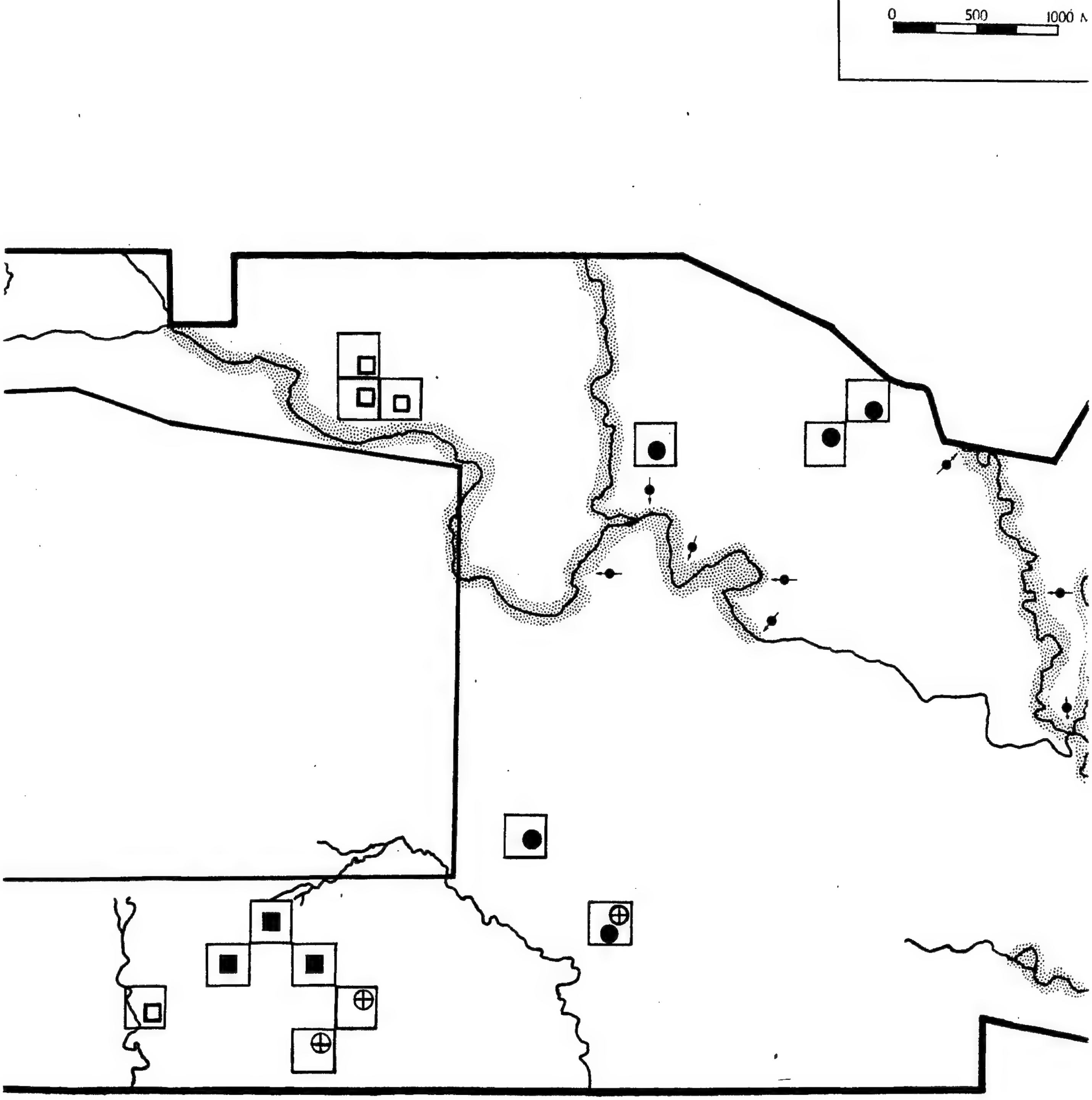
MAP 5

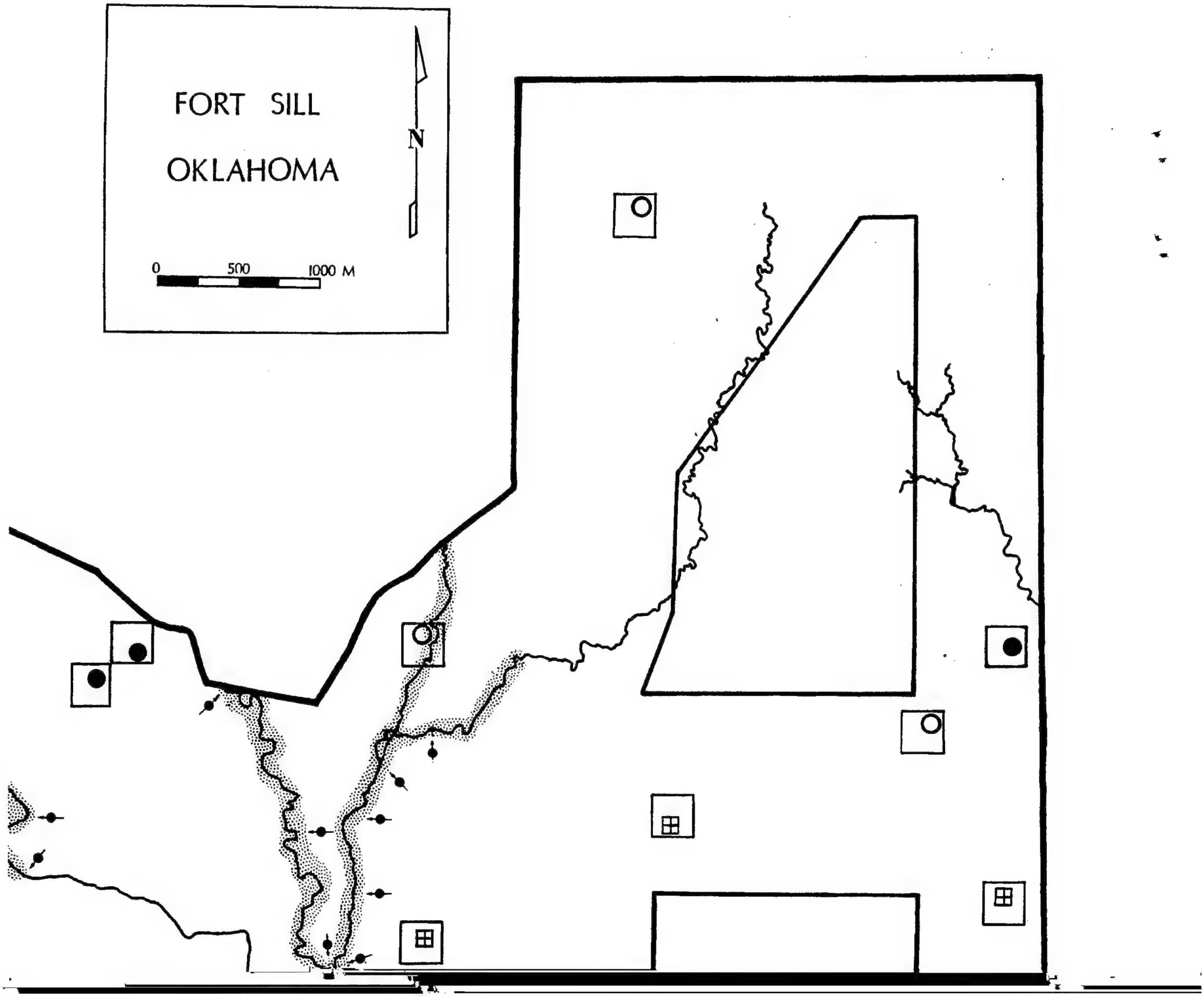


5

FORT SILL

OKLAHOMA




FORT SILL
OKLAHOMA
N
0
500
1000 M

$$\text{(3) Basal Coverage} = \frac{\text{No. of times a species occurred}}{\text{No. of sample plots}} \times 100$$

(4) Importance Value was also used to establish dominance. This value was determined by figuring the Relative density, Relative frequency and Relative Basal coverage of each species (Curtis and McIntosh, 1951). Dominance was set at the hypothetical value of 75% or above for Importance Value.

The stream undergrowth survey was restricted to five stream [illegible]

reconnaissance sampling strategy (Hackenberger, this volume). Five quadrats from each soil type were randomly selected from the list of those quadrats prepared by the archaeologists which were within a given "soil dominant" category (Map 5). With soil maps, the quadrat was visited and a transect through the appropriate soil association was laid out.

Along these transects, a modification of the point contact method was employed to make plant counts (Hansen, 1934). Rather than using a frame, a single rod was used to locate the plants within the sample. At five step intervals along the transect line, the rod was placed at the ground at the point of a notch in the surveyor's boot. The notch served as a fixed reference point to reduce bias. The plant growing under or nearest to the rod was counted. One hundred of these "hits" was recorded for each soil plot, giving a total of five hundred plants for each soil type, dispersed over five separate areas of the reservation. None of these samples was taken from the impact areas. Alternate sample quadrats were also used when disturbance such as mowing, practice ranges, recent range fires, etc. was encountered.

Results

The results of the botanical survey will be presented according to the three separate phases of data collection mentioned above. A standing list of the plants encountered in all phases of data collection is presented first and should be used for the identification of common names as well as generic groupings (Table 6-1). Descriptions of the stream courses surveyed during the stream forest and undergrowth studies will be presented in order to increase the descriptive coverage of the settings for these surveys. In those descriptions will be found the names of species which were observed in the field but which were not encountered by the sampling techniques. The results of the stream forest surveys (Table 6-2 through 6-5) and the results of the undergrowth surveys (Table 6-6) are discussed after the descriptions of the streams. The results of the soil surveys (Table 6-7) are then presented, followed by a discussion of the overall results.

Stream forest survey

Table 6-1. Standing list of plant species encountered in the botanical survey of Fort Sill.

Scientific Name	Family Name	Common Name
	EQUISETACEAE	
Equisetum hyemale		Horsetail
	PINACEAE	
Juniperus virginiana		Eastern red cedar
	TYPHACEAE	
Typha angustifolia		Narrowleaf cattail
Typha latifolia		Common cattail
	ZOSTERACEAE	
Potamogeton sp.		Pondweed
	ALISMACEAE	
Echinodorus cordifolius		Erect burhead
	GRAMINEAE	
Agropyron smithii		Western wheatgrass
Alopecurus carolinianus		Carolina foxtail
Andropogon gerardi		Big bluestem
Andropogon saccharoides		Silver bluestem
Andropogon scoparius		Little bluestem
Andropogon virginicus		Broom sedge
Aristida sp.		Threeawn
Bouteloua curtipendula		Sideoats grama
Bouteloua gracilis		Blue grama
Bouteloua hirsuta		Hairy grama
Bromus tectorum		Downy bromegrass

GRAMINEAE (Cont'd)

Chloris verticillata	Tumble windmillgrass
Cynodon dactylon	Bermudagrass
Echinochloa crusgalli	Barnyardgrass
Elymus sp.	Wildrye
Eragrostis sp.	Lovegrass
Eragrostis trichodes	Sand lovegrass
Lolium perenne	Ryegrass
Muhlenbergia sp.	Muhly
Panicum sp.	Panicgrass
Panicum obtusum	Vine-mesquite
Panicum virgatum	Switchgrass
Sorghastrum nutans	Indiangrass
Sorghum halepense	Johnsongrass
Sporobolus sp.	Dropseed
Uniola latifolia	Broadleaf uniola

CYPERACEAE

Carex sp.	Sedge
Cyperus sp.	Flatsedge
Eleocharis sp.	Spikesedge
Scirpus sp.	Bulrush

LILIACEAE

Allium sp.	Wild onion
Erythronium albidum	Dogtooth lily
Nothoscordium bivalve var. coloratum	Yellow falsegarlic
Smilax sp.	Greenbriar
Yucca glauca	Small soapweed

SALICACEAE

Populus deltoides	Eastern cottonwood
Salix interior	Sandbar willow
Salix nigra	Black willow

JUGLANDACEAE

Carya illinoensis	Pecan
Juglans nigra	Black walnut

FAGACEAE

Quercus macrocarpa	Bur oak
Quercus marilandica	Blackjack oak
Quercus muhlenbergii	Chinquapin oak
Quercus shumardii var. *shumardii*	Shumard oak
Quercus stellata	Post oak

ULMACEAE

Celtis reticulata	Netleaf hackberry
Ulmus americana	American elm

MORACEAE

Maclura pomifera	Osage - orange
Morus rubra	Red mulberry

POLYGONACEAE

Eriogonum sp.	Wild buckwheat
Polygonum sp.	Smartweed
Rumex sp.	Dock

PORTULACACEAE

Claytonia virginica	Virginia springbeauty

CARYOPHYLLACEAE

Cerastium brachypodum	Mouse-eared chickweed

ILLECEBRACEAE

Paronychia jamesii	James nailwort

RANUNCULACEAE

Ranunculus longirostris	Crowfoot

MENISPERMACEAE

Cocculus carolinus	Carolina snailseed

FUMARIACEAE

Corydalis curvisiliqua	Scrambled eggs

CRUCIFERAE

Draba sp.	Draba
Erysimum capitatum	Plains erysimum
Lesquerella sp.	Bladderpod
Rorippa islandica	Bog marshcress

CRASSULACEAE

Sedum sp.	Stonecrop

SAXIFRAGACEAE

Heuchera americana	Allum root
Ribes odoratum	Clove current

ROSACEAE

Rosa multiflora	Wildrose
Prunus sp.	Wild plum
Rubus louisianus	Louisiana blackberry

LEGUMINOSAE

Amorpha fruticosa	Indigobush amorpha
Baptisia sp.	Wild indigo
Cercis canadensis	Eastern redbud
Desmodium sp.	Tickclover
Gymnocladus dioica	Kentucky coffeebean
Lespedeza sp.	Lespedeza
Medicago sativa	Yellow sweetclover
Melilotus alba	White sweetclover
Melilotus officinalis	Wild alfalfa
Prosopis glandulosa	Mesquite
Robinia pseudo-acacia	Black locust
Schrankia uncinata	Catclaw sensitivebrier

SAPINDACEAE

Sapindus drummondii	Western soapberry

VITACEAE

Parthenocissus quinquefolia	Virginia creeper
Vitis sp.	Wild grape

MALVACEAE

Callirhoe involucrata	Low poppymallow

TAMARICACEAE

Tamarix gallica	Salt cedar

VIOLACEAE

Viola missouriensis	Missouri violet
Viola rafinesquii	Johnny jump-up

CACTACEAE

Opuntia compressa	Common pricklypear

ONAGRACEAE

Gaura sp.	Gaura
Jussiaea repens var. *glabrescens*	Smooth water primrose
Oenothera sp.	Evening primrose
Oenothera laciniata var. *laciniata*	Cutleaf evening primrose

UMBELLIFERAE

Chaerophyllum texanum	Spreading chervil
Cicuta maculata	Spotted waterhemlock
Conium maculatum	Poison hemlock
Daucus pusillus	Southwestern carrot
Eryngium diffusium	False thistle
Lomatium foeniculaceum	Hairy parsley

CORNACEAE

Cornus drummondii	Roughleaf dogwood

SAPOTACEAE

Bumelia lanuginosa	Chittomwood

EBENACEAE

Diospyros virginiana	Common persimmon

OLEACEAE

Forestiera pubescens	Desert olive
Fraxinus pennsylvanica var. subintegerrima	Green ash

APOCYNACEAE

Amsonia ciliata var. texana	Texas slimpod

ASCLEPIADACEAE

Asclepias sp.	Milkweed
Asclepias stenophylla	Slimleaf milkweed

CONVOLVULACEAE

Evolvulus Nuttallianus	Silver evolvulus

POLEMONIACEAE

Gilia rubra	Texasplume

HYDROPHYLLACEAE

Ellisia nyctelea	Wild tomato

BORAGINACEAE

Lithospermum incisum	Corn gromwell
Myosotis sp.	Forget-me-not

VERBENACEAE

Verbena sp.	Verbena

LABIATAE

Lamium amplexicaule	Henbit mint
Lycopus americanus	American bugleweed
Mentha spicata	Peppermint
Monarda sp.	Beebalm
Prunella caroliniana	Heal-all
Satureja arkansana	Calamint
Scutellaria sp.	Skullcap

SCROPHULARIACEAE

Collinsia violacea	Violet collinsia
Penstemon sp.	Penstemon

BIGNONIACEAE

Catalpa bignoniodes	Catalpa

ACANTHACEAE

Dianthera americana	Water willow
Ruellia sp.	Wild petunia

PLANTAGINACEAE

Plantago sp.	Plantain

RUBIACEAE

Cephalanthus occidentalis	Common buttonbush
Galium sp.	Bedstraw
Hedyotis crassifolia	Tiny bluet
Hedyotis nigricans	Narrowleaf bluet

CAPRIFOLIACEAE

Symphoricarpos orbiculatus	Coral berry (Buck brush)

VALERIANACEAE

Valerianella sp.	Cornsalad

CAMPANULACEAE

Specularia sp.	Venus-lookingglass

COMPOSITAE

Achillea lanulosa	Western yarrow
Ambrosia psilostachya	Western ragweed
Artimisia glauca	False terragon sagewart
Artimisia ludoviciana var. ludoviciana	Louisiana sagewart
Aster ericoides	Heath aster
Aster oblongifolius	Aromatic aster

COMPOSITAE (Cont'd)

Bidens sp.	Beggarticks
Chrysopsis pilosa	Soft goldaster
Chrysopsis villosa var. villosa	Hairy goldaster
Cirsium undulatum	Wavyleaf thistle
Coreopsis tinctoria	Plains coreopsis
Echinacea angustifolia	Blacksamson
Engelmannia pinnatifida	Engelmann daisy
Erigeron sp.	Fleabane
Eupatorium serotinum	Late eupatorium
Gnaphalium sp.	Cudweed
Gutierrizia dracunculoides	Common broomweed
Helianthus annus	Common sunflower
Hymenopappus tenuifolius	Chalkhill woollywhite
Hymenoxys linearifolia	Fineleaf actinea
Liatris punctata	Dotted gayfeather
Pyrrhopappus carolinianus	Carolina false-dandelion
Ratibida columnifera	Goright prairie-coneflower
Senecio plattensis	Prairie groundsel
Solidago sp.	Goldenrod
Sonchus sp.	Sow thistle
Taraxacum officinale	Common dandelion
Thelesperma filifolium	Plains greenthread
Vernonia sp.	Ironweed
Xanthium strumarium	Cocklebur

Table 6-2. Percent composition of trees along major streams at Fort Sill.

	East Cache Creek	Beef Creek	Frisco Creek	Blue Beaver Creek	Medi-cine Creek	Crater Creek	Ketch Creek	Sitting Bear Creek	Post Oak Creek	West Cache Creek	Cumu-lative Average %'s
No. of Sample Plots	50	50	40	35	50	35	25	25	35	35	
No. of Trees	739	636	432	489	765	480	360	526	596	472	
Ailanthus altissima	0.1	--	--	--	--	--	--	--	--	--	0.01
Bumelia lanuginosa	1.4	1.3	0.2	1.8	1.2	2.7	1.1	0.2	4.4	3.0	1.7
Carya illinoensis	14.1	9.3	21.1	14.9	12.3	15.8	3.1	9.7	13.1	11.2	12.5
Catalpa bignoniodes	--	--	--	--	0.5	--	--	--	0.2	--	0.07
Celtis reticulata	31.4	12.9	9.7	9.6	6.1	12.5	11.1	8.4	3.2	11.0	11.6
Cephalanthus occidentalis	--	--	--	0.4	--	--	--	--	0.2	--	0.06
Cercis canadensis	--	0.6	--	0.6	0.9	--	0.3	--	--	--	0.2
Diospyros virginiana	--	--	--	6.5	--	4.0	--	--	0.8	--	1.1
Fraxinus pennsylvanica	17.9	5.5	20.4	12.1	6.9	10.2	20.3	8.6	4.5	8.7	11.5
Gymnocladius dioica	0.4	0.2	--	--	0.1	--	--	--	--	--	0.07
Juglans nigra	1.2	0.5	--	10.1	6.0	11.3	5.0	4.6	7.9	9.8	5.6
Juniperus virginiana	--	--	--	1.2	--	1.0	--	--	3.9	4.7	1.1
Maclura pomifera	0.4	--	--	--	--	--	--	--	0.3	--	0.07
Morus rubra	0.1	--	--	--	--	--	--	--	--	--	0.01
Populus deltoides	3.1	4.9	7.6	0.6	2.4	2.3	1.9	2.3	2.2	--	2.7
Quercus macrocarpa	11.9	17.6	--	--	27.7	--	25.8	30.8	--	--	11.4
Quercus marilandica	--	0.2	--	2.5	--	7.7	0.3	--	13.4	7.8	3.2
Quercus muehlenbergii	--	--	--	--	0.9	--	--	--	--	--	0.1
Quercus shumardii	0.2	26.1	--	0.4	4.3	--	6.1	0.6	2.9	--	4.1
Quercus stellata	--	--	--	1.8	0.5	9.6	3.1	--	11.4	9.8	3.6
Salix nigra	--	0.2	2.1	2.9	0.4	2.5	--	--	1.7	0.4	1.0
Sapindus drummondii	--	--	3.5	1.2	--	2.3	0.3	0.6	0.2	1.5	1.0
Ulmus americana	17.9	20.9	35.4	33.3	29.7	18.3	21.7	34.4	29.9	32.2	27.4

portion of Fort Sill. Beef, Sitting Bear, and Medicine Creeks all flow into East Cache, which eventually empties into the Red River some 55 km downstream. Its banks are rather gradual and sloping at the northern portion of the reservation, with densely forested areas along the margins (Figure 6-1,a). Near the area where Beef, East Cache, and Medicine Creeks all converge, the water becomes very muddy (with a generally wide channel) and the banks become steep or vertical. These banks usually stand 10 to 15 feet above the actual channel. Approximately three-fourths of the way downstream, Fort Sill Sewage Treatment Plant empties into East Cache making it even more muddy and full of impurities.

East Cache not only flows year round, but is utilized by many smaller towns to the south for irrigation and drinking water supply.

The area surrounding East Cache is either very flat or gradually rolling prairie grassland. The influence of blackjack, post oak communities and granite formations are absent. Port and Port clay loam are the major soil types found throughout on this stream, and produce a very rich topsoil. There are very wide stands of large trees throughout on East Cache.

The Dominant Species found on East Cache is Celtis reticulata with an Importance Value of 84.6. This value is largely due to a 94% value on pure frequency, but also is due to the reading of 31.4% on relative Density. The distribution of this species is even throughout, peaking in a number of places from mid creek to the southern boundary.

Sub-Dominant Species and their importance values are as follows:

(1) [illegible] evenly distributed throughout.
(2) Fraxinus pennsylvanica (49.7) The heaviest concentration of this species occurred around mid creek, and spotted in concentrations on either end.
(3) Carya illinoensis (43.9)
(4) Quercus macrocarpa (36.3)

Other species seen but not hit in sampling were Cephalanthus occidentalis, Cercis canadensis, Juniperus virginiana, Salix nigra, and Sapindus drummondii.

3. Basal coverage of tree species along major streams at Fort Sill.

t e k	Beef Creek	Frisco Creek	Blue Beaver Creek	Medi- cine Creek	Crater Creek	Ketch Creek	Sitting Bear Creek	Post Oak Creek	West Cache Creek	Cumu- lative Average %'s
	50	40	35	50	35	25	25	35	35	
	636	432	489	765	480	360	526	596	472	
2	--	--	--	--	--	--	--	--	--	0.02
0	1.6	0.3	2.6	1.8	3.7	1.6	0.4	7.4	4.0	2.5
3	11.8	22.8	20.9	18.8	21.7	4.4	20.4	22.3	15.1	17.9
	--	--	--	0.8	--	--	--	0.3	--	0.1
4	16.4	10.5	13.4	9.4	17.1	16.0	17.6	5.4	14.9	16.7
	--	--	0.6	--	--	--	--	0.3	--	0.09
	0.8	--	0.9	1.4	--	0.4	--	--	--	0.4
	--	--	9.1	--	5.4	--	--	1.4	--	1.6
4	7.0	22.0	16.9	10.6	14.0	29.2	18.0	7.7	11.7	16.4
6	0.2	--	--	0.2	--	--	--	--	--	0.1
3	0.6	--	14.0	9.2	15.4	7.2	9.6	13.4	13.1	8.4
	--	--	1.7	--	1.4	--	--	6.6	6.3	1.6
6	--	--	--	--	--	--	--	0.6	--	0.1
2	--	--	--	--	--	--	--	--	--	0.02
6	6.2	8.3	0.9	3.6	3.1	2.8	4.8	3.7	--	3.8
5	22.4	--	--	42.4	--	37.2	64.8	--	--	18.4
	0.2	--	3.4	--	10.6	0.4	--	22.9	10.6	5.8
	--	--	--	1.4	--	--	--	--	--	0.1
2	33.2	--	0.6	6.6	--	8.8	1.2	4.9	--	5.6
	--	--	2.6	0.8	13.1	4.4	--	19.4	13.1	5.3
	0.2	2.3	4.0	0.6	3.4	--	--	2.9	0.6	1.4
	--	3.8	1.7	--	3.1	0.4	1.2	0.3	2.0	1.3
4	26.6	38.3	46.6	45.4	24.9	31.2	72.4	50.9	43.4	40.6

Beef Creek is an intermittent secondary stream and usually has very little water in it. Beef Creek runs north to south emptying into East Cache. The channel is rather wide at the extreme southern end, but narrows greatly about 2 km upstream and remains rather narrow to the northern extremity. The banks above the stream channel are rather steep. The forest areas along the stream are dense for around half the distance of the stream heading upstream, or to the north. The last half of the stream thins out greatly and in a few areas the channel is flanked by only a few trees.

The area surrounding this stream is flat open grassland prairie. There are a number of dense isolated stands of chinaberry, sumac, wild plum, and black locust found in these open fields along the stream both up and downstream.

There is no dominant species on Beef Creek as interpreted by importance value.

Of the sub-dominant species however, (1) Quercus shumardii (67.[illegible]) is very close to being dominant. It is found [illegible]

numbers at the extreme southern end, then picks up just before mid stream and for a distance of around 3.5 km it occurs in very large numbers, only to drop off sharply again at the northern end. Other sub-dominants are:

(2) Ulmus americana (58.7)
(3) Quercus macrocarpa (54.9)
(4) Celtis reticulata (36.4)
(5) Carya illinoensis (29.2)
(6) Fraxinus pennsylvanica (20.6)
(7) Populus deltoides [illegible]

Table 6-4. Percent frequency of tree species along major streams at Fort Sill.

	East Cache Creek	Beef Creek	Frisco Creek	Blue Beaver Creek	Medi- cine Creek	Crater Creek	Ketch Creek	Sitting Bear Creek	Post Oak Creek	West Cache Creek	Cumu- lative Average %'s
ole Plots	50	50	40	35	50	35	25	25	35	35	
s	739	636	432	489	785	480	360	526	596	472	
tissima	2.0	--	--	--	--	--	--	--	--	--	0.2
uginosa	14.0	12.0	2.5	23.0	14.0	22.9	12.0	4.0	37.1	28.6	17.0
ensis	68.0	46.0	70.0	63.0	66.0	57.1	32.0	60.0	68.6	45.7	57.6
oniodes	--	--	--	--	8.0	--	--	--	2.9	--	1.1
ulata	94.0	46.0	42.5	66.0	56.0	57.1	68.0	72.0	31.4	51.4	58.4
s occidentalis	--	--	--	5.7	--	--	--	--	2.9	--	0.9
densis	--	8.0	--	5.7	8.0	--	4.0	--	--	--	2.6
irginiana	--	--	--	34.3	--	20.0	--	--	2.9	--	5.7
nnsylvania	60.0	42.0	65.0	63.0	40.0	62.9	92.0	44.0	37.1	54.3	56.0
us dioica	6.0	2.0	--	--	2.0	--	--	--	--	--	1.0
a	12.0	4.0	--	71.4	50.0	68.6	48.0	48.0	54.3	54.3	41.1
irginiana	--	--	--	14.3	--	11.4	--	--	42.9	34.3	10.3
nifera	6.0	--	--	--	--	--	--	--	5.7	--	1.2
a	2.0	--	--	--	--	--	--	--	--	--	0.2
toides	32.0	46.0	40.0	5.7	20.0	22.9	20.0	20.0	17.1	--	22.4
crocarpa	54.0	86.0	--	--	86.0	--	92.0	100.0	--	--	41.8
rilandica	--	2.0	--	20.0	--	41.9	4.0	--	77.1	48.6	19.4
ihlenbergii	--	--	--	--	6.0	--	--	--	--	--	0.6
umardii	2.0	66.0	--	3.0	12.0	--	28.0	16.0	20.0	--	14.7
ellata	--	--	--	23.0	6.0	51.4	36.0	--	45.7	48.6	21.1
	--	2.0	17.5	23.0	4.0	20.0	--	--	5.7	5.7	7.8
rummondii	--	--	15.0	3.0	--	17.1	4.0	12.0	2.9	8.6	6.3
ricana	80.0	74.0	85.0	100.0	90.0	94.3	80.0	100.0	97.1	88.6	88.9

...nce values of tree species along major streams at Fort Sill.

	Frisco Creek	Blue Beaver Creek	Medi-cine Creek	Crater Creek	Ketch Creek	Sitting Bear Creek	Post Oak Creek	West Cache Creek	Cumu-lative Average %'s
	40	35	50	35	25	25	35	35	
	432	498	765	480	360	526	596	472	
	--	--	--	--	--	--	--	--	0.1
	1.2	8.1	5.4	9.6	4.5	1.2	15.4	12.1	6.9
	62.9	41.8	38.7	42.1	12.4	32.0	38.6	32.2	37.4
	--	--	2.7	--	--	--	0.9	--	0.4
	32.0	31.8	24.2	35.4	35.3	31.9	12.1	33.1	35.7
	--	1.9	--	--	--	--	0.9	--	0.3
	--	2.3	3.5	--	1.4	--	--	--	1.0
	--	19.5	--	11.6	--	--	2.1	--	3.3
	60.0	36.2	22.3	31.9	58.3	26.4	15.7	29.0	35.0
	--	--	0.6	--	--	--	--	--	0.4
	--	33.7	22.7	35.0	19.2	19.3	25.6	31.1	19.4
	--	5.1	--	4.1	--	--	15.6	16.6	4.1
	--	--	--	--	--	--	1.7	--	0.4
	--	--	--	--	--	--	--	--	0.1
	27.2	2.2	9.1	8.8	7.6	8.8	7.5	--	10.5
	--	--	73.8	--	69.3	82.6	--	--	31.7
	--	8.7	--	23.1	1.4	--	40.8	26.1	10.1
	--	--	3.1	--	--	--	--	--	0.3
	--	1.4	11.2	--	17.6	4.6	9.4	--	11.2
	--	8.1	2.3	28.6	13.1	--	31.1	29.9	11.3
	9.4	10.2	1.7	8.7	--	--	4.4	2.0	3.7
	11.4	3.0	--	7.7	1.4	3.7	0.9	4.8	3.3
	96.0	85.7	78.6	53.7	58.8	89.8	77.4	83.3	73.6

of chinaberry, black locust, sumac and wild plum found in the surrounding open prairie.

The dominant species on this stream is *Ulmus americana* with an importance value of 96.0. This species is quite evenly distributed throughout on this stream.

Sub-dominants and their importance values are:

(1) *Carya illinoensis* (62.9) This species was very close to being considered dominant. It however, was found to occur in larger numbers at the northern end, and then leveling off to spotted occurrences throughout.
(2) *Fraxinus pennsylvanica* (60.0) This species was also very close to being considered dominant. This species peaked in numbers at mid creek, and again at an isolated area at the northern end. It also is spotted throughout.
(3) *Celtis reticulata* (32.0)
(4) *Populus deltoides* (27.2)

Other species seen but not hit in sampling were *Cephalanthus occidentalis*, *Cercis canadensis*, *Juglans nigra*, *Juniperus virginiana*, *Quercus macrocarpa*, and *Quercus shumardii*.

Sitting Bear Creek is an intermittent stream located within and south of the Cantonment area. Much of this stream was not surveyed, because of tremendous domestic disturbance in the form of recreational areas. This stream is usually very dry, except for isolated "pot-holes" of water, or after a rain.

It has a wide channel, and very densely wooded margins. A tremendous amount of beaver activity and cuttings were noted on Sitting Bear. There were literally hundreds of cut young saplings [illegible] trees. The beavers seemed to be selective on the

(1) Ulmus americana (89.8)
(2) Quercus macrocarpa (82.6)

Both of these species are considered dominant primarily due to their 100% pure frequency score on this stream. Both are found equally distributed throughout. Elm is very consistent in number throughout while burr oak peaks at midstream.

Sub-dominants and their importance values are:

(1) Carya illinoensis (32.0)
(2) Celtis reticulata (31.9)
(3) Fraxinus pennsylvanica (26.4)
(4) Juglans nigra (19.3)

Other species present but not hit in sampling are Cephalanthus occidentalis, Cercis canadensis, Juniperus virginiana, Quercus marilandica, and Quercus stellata.

Medicine Creek is the second largest stream which crosses Fort Sill, with a catchment area only smaller than East Cache Creek's. Unlike the latter stream, however, Medicine Creek's catchment upstream from the reservation is almost entirely within the Wichita Mountains. Hence this stream is noted for its abundant supply of fresh water which persisted until construction of Lake Lawtonka altered its natural flow. Several prolific springs occur along this stream within the reservation, the most famous being Ambrosia Springs near the Old Post Quadrangle.

The stream flows in a southeasterly to easterly direction finally merging with East Cache Creek. Unlike the latter stream, Medicine Creek is flanked along most of its course by continuous or in places irregular granite and rhyolite hills or bluffs. Medicine Bluffs, the most famous landmark in the area, is the most prominant case of this situation. Broad high terraces flank portions of the stream course which winds irregularly through the reservation, apparently following fault lines in places. It flows year round, and is extremely clear due to the granite formations that produce its sandy bottom.

The lower portion of the creek meanders through a residential area of Fort Sill. This are was not used for survey. It had undergone tremendous alterations, and was in most cases not representative of the natural environment found throughout the rest of this stream.

The northern one-half of Medicine Creek's valley is surrounded by upland post oak and blackjack forests as was the case with West Cache, Post Oak, and Crater Creeks.

There are two dominant species on Medicine Creek. One is Ulmus americana with an importance value of 78.6. The other, interestingly enough, did not even occur on any streams surveyed west of Medicine Creek. It is Quercus macrocarpa with an importance value of 73.8. It actually fell a little short of the arbitrary importance value of 75.0, but it was close enough to be considered dominant. Ulmus americana was found evenly distributed throughout. Quercus macrocarpa however, was found in relatively small numbers at the northwestern end, and increased in abundance about one-third of the way down stream where it peaks, levels off and peaks again. It then levels off and remains evenly distributed for the remainder of the southern end of the stream.

Sub-dominant species and importance values are as follows:

(1) Carya illinoensis (38.7)
(2) Celtis reticulata (24.2)
(3) [illegible]

(3) Fraxinus pennsylvanica (58.3)

All of which are found evenly distributed throughout.

(4) Celtis reticulata (35.3)
(5) Juglans nigra (19.2)

Other species seen but not hit on the survey were Juniperus virginiana and Salix nigra.

Blue Beaver Creek is the major stream west of Medicine and East Cache Creeks. It flows nearly year round in a southerly direction through steep granite and rhyolite hills (Figures 6-1, c-d). Near the south boundary, however, the valley broadens as it emerges to the prairie. There the valley is characterized by a wide creek channel, and heavily wooded areas surrounded by relatively open and

except in a few isolated areas of S-shaped meanders. Crater is also surrounded above by blackjack and post oak upland forest communities.

By definition of dominance set at 75% or above for importance value, there are not any dominant species on Crater Creek.

The sub-dominant species, however, are numerous and are listed as follows:

(1) Ulmus americana (53.7) This species has the highest importance value and is evenly distributed throughout in relatively small numbers. It also has a pure frequency value of 94.3%, which explains its dominance over the other sub-dominant species.
(2) Carya illinoensis (42.1)
(3) Celtis reticulata (35.4)
(4) Juglans nigra (35.0)
(5) Fraxinus pennsylvanica (31.9)
(6) Quercus stellata (28.6)
(7) Quercus macrocarpa (23.1)

Additional species seen but not hit in sampling on Crater Creek are Cercis canadensis, Quercus shumardii, and Cephalanthus occidentalis.

West Cache Creek is located on Fort Sill's Quanah Range, west of Crater Creek. Granite rock outcrops at its northern end form very steep cliffs present above the creek channel. Although it is considered an intermittent stream it usually has some water in it all year long. The stream channel remains relatively wide, with extremely sandy granite parent material throughout. The forested areas of this stream are largely on Port and Breaks alluvial soils. Above the stream on both sides are heavy concentrations of upland forests of blackjack and post oaks.

Ulmus americana, with an importance value of 83.3 is the only species which can be considered dominant on this creek. Heaviest distributions of Ulmus americana are found near the southern and northern boundaries, and are very equal in number and concentration. The dominancy of Ulmus americana is primarily due to its very high pure frequency value of 88.6%.

There were six species which were categorized as "sub-dominant species." These and their importance values are as follows:

(1) *Carya illinoensis* (32.2)
(2) *Celtis reticulata* (33.1)
(3) *Fraxinus pennsylvanica* (29.0)
(4) *Juglans nigra* (31.1)
(5) *Quercus marilandica* (26.1)
(6) *Quercus stellata* (29.9)

Four additional species seen but not hit by sampling technique on West Cache were: *Cephalanthus occidentalis*, *Cercis canadensis*, and *Populus deltoides*.

Post Oak Creek is the western most major stream on the reservation. It flows along the western boundary after emerging from the rugged hills just north of Fort Sill (Figure 6-2,b).

It is almost identical in physical discription to that of West Cache Creek. The only exception being the absence of steep granite cliff formations at the northern end, as was found on West Cache

Stream Undergrowth Survey

The undergrowth survey of the five streams resulted in the tabulation of a total of 125 different species (Table 6-6). This very cumbersome list poses obvious problems in interpretation. The number of species on a given stream is a simple index of diversity of variability which is useful for stream comparison. While all streams except East Cache Creek had somewhat more numerous species on the floodplains than above them, the relative numbers of species in these two situations is about the same for each of the five streams. Marked differences are apparent, however, among streams with respect to the number of species present in sampling. East Cache Creek is the lowest, or least diverse, in this respect; it has 27 species on the floodplain and 29 above the flood plain. Nearby Beef Creek is the next most diverse, with 32 and 31 species, respectively. Medicine Creek displays considerably higher variability, and Blue Beaver and Post Oak creeks are the most diverse. The latter streams, with 57 and 55 species respectively on their floodplains, are more than twice as "diverse" as East Cache Creek using this simple index.

With one exception, the numbers of economic plants follow the same pattern as total numbers of species. Economic plants are those defined ethnographically as having been used by Plains Indian groups. The number of economic species increases from five on the floodplain of East Cache Creek to 12 on the floodplain of Post Oak Creek. Blue Beaver Creek has only seven economic species on its floodplain, an amount which is not proportional to its overall diversity. When the frequency of these economic plants is examined, the original ordering of the stream floodplains is repeated. East Cache Creek is low, with .57%, and Post Oak Creek is high with 14.26%.

Using an arbitrary cut-off of 9.00%, or above for dominant species, further patterns of variability may be delineated among the five streams. Only ten species attained a frequency of 9.00%, and none of these ten appears to be a single dominant on either the floodplain or above the floodplains of any of the five streams. These ten species will be briefly reviewed, with the main patterns of variability being described.

Carex sp. (sedges) are clearly associated with the floodplain vegetation but are quite variable in their occurrence across the five streams. These plants do attain a simple majority of the species counted on Medicine Creek's floodplain (53.7%) and are also very frequent along East Cache Creek (26.3%). Post Oak Creek is lowest of the other three streams in sedges, with only 4.4%.

Table 6-6. Stream Undergrowth Survey
species represented in percentages

Plant Species	Beef Creek		Medicine Creek		East Cache Creek		Blue Beaver Creek		Post Oak Creek		Average Compositions	
	AF**	F**	AF	F	AF	F	AF	F	AF	F	AF	F
Elymus sp.	15.98	5.62	4.54	0.25	34.72	4.34	1.15	0.88	3.95	2.30	12.07	2.68
Carex sp.	3.92	9.87	0.55	53.70	2.89	26.30	0.89	9.70	0.51	4.44	1.75	19.91
Rhus toxicodendron	17.47	15.80	19.74	4.99	0.17	0.25	–	–	15.17	3.65	10.51	4.91
Parthenocissus quinquefolia	8.87	18.16	7.71	0.92	–	–	–	–	6.20	3.12	4.56	4.44
Fraxinus pennsylvanica	0.23	4.24	0.03	–	0.04	–	–	–	0.05	–	0.07	0.85
Smilax sp.*	8.15	–	6.95	0.34	0.42	0.53	6.90	2.32	6.30	5.64	5.74	1.77
Symphoricarpos orbiculatus	17.29	1.27	8.31	–	17.31	–	14.39	0.46	4.70	–	12.40	0.35
Artimisia ludoviciana var. ludoviciana	3.96	1.27	2.17	0.01	0.38	–	6.47	0.62	2.12	1.83	3.02	0.75
Quercus macrocarpa*	0.11	–	0.12	–	–	–	–	–	0.03	–	0.05	–
Chaerophyllum texanum	0.47	1.75	5.46	1.11	9.17	2.47	13.35	12.53	0.39	1.67	5.77	3.91
Celtis reticulata*	0.09	–	0.17	–	0.03	–	0.07	–	0.06	–	0.08	–
Uniola latifolia	2.77	18.82	9.71	1.99	17.41	5.64	14.63	35.10	19.50	34.13	12.80	19.14
Galium sp.	3.0	13.22	1.07	2.55	6.16	17.52	1.00	4.57	0.04	0.51	2.25	7.67
Carya illinoensis*	0.04	–	–	–	–	–	–	–	0.03	–	0.01	–
Sapindus drummondii	0.25	–	–	–	0.67	–	0.13	–	0.08	0.08	0.23	0.02
Sorghum halepense	7.78	3.91	8.03	3.29	2.68	1.77	19.78	7.25	11.29	10.95	9.91	5.43
Cercis canadensis	0.05	–	0.06	–	0.02	–	0.31	–	–	–	0.09	–
Ulmus americana	1.03	–	0.26	–	0.15	–	0.39	–	8.62	–	2.09	–
Taraxacum officinale*	0.04	0.03	0.56	–	0.04	0.33	1.84	1.29	0.09	1.14	0.51	0.56
Vitis sp.*	0.50	1.0	1.51	–	–	–	–	–	1.55	6.19	0.71	1.44
Ellisia nyctelea	0.40	0.80	4.44	0.85	–	–	–	–	0.65	1.02	1.10	0.53
Cornus drummondii	4.02	1.25	2.94	0.03	–	–	–	–	–	–	1.39	0.26
Oxalis sp.	0.02	0.01	–	–	–	0.02	0.18	0.15	0.04	0.05	0.05	0.05
Andropogon scoparius	3.75	–	–	–	–	–	0.62	0.15	–	–	0.87	0.03
Rhus sp.*	0.75	–	–	–	–	–	0.15	–	4.18	1.64	1.02	0.33
Achillea lanulosa	0.03	–	0.52	–	–	–	0.56	0.05	0.28	0.02	0.28	0.01

Table 6-6 Continued

Bumelia lanuginosa	–	–	0.03	–	–	–	0.02	–	0.05	–	0.02	–
Juniperus virginiana*	–	–	0.03	–	0.03	–	–	–	0.08	–	0.03	–
Forestiera pubescens	–	–	0.01	–	–	–	–	–	–	–	0.002	–
Andropogon gerardi	–	–	0.02	–	–	–	–	–	–	–	0.004	–
Panicum sp.	–	–	0.02	–	–	–	5.93	2.97	0.06	1.65	1.20	0.92
Sorghastrum nutans	–	–	0.05	–	–	–	–	0.60	0.75	3.20	0.16	0.76
Ribes odoratum	–	–	0.04	–	–	–	–	–	–	–	0.01	–
Equisetum hyemale	–	–	–	4.50	–	0.01	–	–	–	7.25	–	2.37
Melilotus officinalis	–	–	–	0.01	–	–	0.25	–	–	–	0.05	0.002
Cephalanthus occidentalis	–	–	–	0.01	–	–	0.06	0.02	–	0.04	0.01	0.01
Panicum virgatum	–	–	–	5.15	–	0.02	–	3.36	0.33	3.96	0.07	2.50
Cicuta maculata	–	–	–	0.09	–	–	–	3.95	–	–	–	0.81
Cyperus sp.	–	–	–	2.36	–	–	–	–	–	–	–	0.47
Typha sp.*	–	–	–	1.40	–	–	–	–	–	–	–	0.28
Scirpus sp.*	–	–	–	0.51	–	–	–	–	–	–	–	0.10
Eleocharis sp.	–	–	–	4.43	–	–	–	–	–	–	–	0.89
Tamarix gallica	–	–	–	0.03	–	–	–	–	–	–	–	0.01
Plantago sp.*	–	–	–	0.02	–	–	–	0.40	1.77	–	0.35	0.08
Andropogon virginicus	–	–	–	0.77	–	–	–	0.04	–	0.76	–	0.31
Bromus tectorum	–	–	–	0.02	–	–	0.50	–	0.02	0.04	0.10	0.01
Oenothera laciniata var. laciniata	–	–	–	0.01	–	–	–	–	–	–	–	0.002
Potamogeton sp.	–	–	–	0.20	–	–	–	–	–	–	–	0.04
Sporobolus sp.	–	–	–	–	0.01	–	1.25	0.15	1.0	0.03	0.45	0.04
Tribulus terrestris	–	–	–	–	0.20	0.05	–	–	–	–	0.04	0.01
Eragrostis sp.	–	–	–	–	0.02	–	3.76	1.86	0.03	0.03	0.76	0.38
Gaura sp.	–	–	–	–	–	0.05	–	–	–	–	–	0.01
Corydalis curvisiliqua	–	–	–	–	–	0.26	–	0.25	0.03	–	0.01	0.10
Erodium cicutarium	–	–	–	–	–	0.25	–	1.00	–	–	–	0.25
Jussiaea repens var. glabrescens	–	–	–	–	–	6.25	–	–	–	1.25	–	1.50
Asclepias sp.	–	–	–	–	–	0.02	–	–	–	–	–	0.004
Bouteloua curtipendula	–	–	–	–	–	–	0.25	–	–	–	0.05	–
Robinia pseudoacacis*	–	–	–	–	–	–	0.06	–	–	–	0.01	–
Cynodon dactylon	–	–	–	–	–	–	0.25	–	–	–	0.05	–
Artimisia glauca	–	–	–	–	–	–	0.25	–	–	–	0.05	–
Echinochloa crusgalli	–	–	–	–	–	–	0.04	–	–	–	0.01	–
Vernonia sp.	–	–	–	–	–	–	0.04	–	–	–	0.01	–

Table 6-6 Continued

Oenothera sp.	0.02	–	–	–	–	–	–	–	–	–	0.004	–
Specularia sp.	0.02	0.03	2.92	0.02	–	0.76	–	–	0.04	0.05	0.60	0.17
Quercus shumardii*	0.05	–	0.01	–	0.05	–	–	–	–	–	0.02	–
Callirhoe involucrata	0.01	0.25	0.04	0.02	0.02	0.05	0.39	0.09	0.06	–	0.10	0.08
Pyrrhopappus carolinianus	0.70	–	–	–	–	–	–	–	–	–	0.14	–
Alopecurus carolinianus	0.05	–	–	–	–	–	–	0.07	–	–	0.01	0.01
Echinodorus cordifolius	–	0.02	–	–	–	–	–	–	–	–	0.004	–
Dianthera americana	–	0.53	0.25	0.04	0.02	0.25	0.04	–	2.00	0.27	0.46	0.22
Rumex sp.	–	0.02	–	0.06	–	0.21	0.07	0.88	–	–	0.01	0.23
Cerastium brachypodum	–	0.15	0.51	0.02	2.47	23.61	0.05	0.02	–	0.01	0.61	4.76
Erigeron sp.	–	0.12	0.03	2.71	–	2.26	–	–	–	0.50	0.01	1.12
Helianthus annus	–	0.07	0.02	–	–	–	–	–	–	–	0.004	0.01
Lycopus americanus	–	0.01	–	–	–	–	–	–	–	–	–	0.002
Viola missouriensis	–	0.27	–	1.75	0.04	3.89	–	0.89	–	0.95	0.01	1.55
Polygonum sp.	–	0.04	–	0.17	–	0.05	–	–	–	–	–	0.05
Xanthium strumarium	–	1.25	–	–	–	0.07	–	0.25	–	–	–	0.31
Schrankia uncinata	–	0.05	–	–	–	–	–	–	–	0.02	–	0.01
Ranunculus longirostris	–	0.06	4.00	0.02	–	–	–	–	–	–	0.80	0.02
Sonchus sp.	–	0.03	–	–	–	–	–	–	–	–	–	0.01
Larnium amplexicaule	–	–	0.97	–	5.28	3.15	0.15	–	–	0.02	1.28	0.63
Senecio plattensis	–	–	1.75	0.20	–	–	0.31	1.30	0.04	0.09	0.42	0.32
Valerianella sp.	–	–	1.25	0.04	–	–	–	–	–	0.01	0.25	0.01
Rorippa islandica	–	–	0.02	–	–	–	0.03	3.25	–	0.27	0.01	0.70
Hymenoxys linearifolia	–	–	0.52	–	–	–	–	–	–	0.04	0.10	0.01
Cirsium undulatum*	–	–	0.03	–	–	–	0.21	0.03	0.03	0.02	0.05	0.01
Verbena sp.	–	–	0.18	–	–	–	0.29	0.02	0.06	0.04	0.11	0.01
Yucca glauca*	–	–	0.03	–	–	–	–	–	–	0.02	0.01	0.004
Viola rafinesquii	–	–	0.64	–	0.03	0.06	1.05	–	–	0.01	0.34	0.01
Amorpha fruticosa	–	–	0.08	0.07	–	–	–	–	–	–	0.02	0.01
Aristida sp.	–	–	0.25	–	–	–	0.15	0.50	–	–	0.08	0.10
Medicago sativa	–	–	1.08	3.16	–	–	–	–	2.35	0.33	0.69	0.70
Melilotus alba												
Bidens sp.	–	–	0.20	0.04	–	–	–	–	–	–	0.04	0.01
Thelesperma filifolium	–	–	0.26	–	–	–	–	–	–	–	0.05	–

Table 6-6 Continued

Vicia dasycarpa	–	–	–	–	–	–	0.85	–	–	–	0.17	–
Satureja arkansana	–	–	–	–	–	–	0.25	–	–	–	0.05	–
Ruellia sp.	–	–	–	–	–	–	0.35	–	–	–	0.07	–
Collinsia violacea	–	–	–	–	–	–	0.68	0.40	–	–	0.14	0.08
Ratibida columnifera	–	–	–	–	–	–	0.01	–	–	–	0.002	–
Draba sp.	–	–	–	–	–	–	0.07	–	0.04	–	0.02	–
Erysimum capitatum	–	–	–	–	–	–	0.03	–	1.25	0.03	0.26	0.01
Muhlenbergia sp.	–	–	–	–	–	–	0.15	–	2.5	–	0.53	–
Hedyotis nigricans	–	–	–	–	–	–	0.04	–	0.03	–	0.01	–
Lesquerella	–	–	–	–	–	–	0.04	–	0.03	0.03	0.01	0.01
Bouteloua hirsuta	–	–	–	–	–	–	0.04	–	0.03	–	0.01	–
Lithospermum incisum	–	–	–	–	–	–	0.03	–	–	–	0.01	–
Diospyros virginiana*	–	–	–	–	–	–	0.10	–	–	–	0.02	–
Andropogon saccharoides	–	–	–	–	–	–	0.10	–	–	–	0.02	–
Heuchera americana	–	–	–	–	–	–	–	1.20	–	–	–	0.24
Rosa multiflora	–	–	–	–	–	–	–	0.25	–	–	–	0.05
Gilia rubra	–	–	–	–	–	–	–	0.02	0.03	–	0.01	0.004
Eryngium diffusium	–	–	–	–	–	–	–	0.15	–	–	–	0.03
Solidago sp.	–	–	–	–	–	–	–	0.02	–	–	–	0.004
Prunella caroliniana	–	–	–	–	–	–	–	0.04	–	–	–	0.01
Claytonia virginic	–	–	–	–	–	–	–	0.05	0.02	–	0.004	0.01
Allium sp.*	–	–	–	–	–	–	–	0.79	–	–	–	0.16
Eupatorium serotinum	–	–	–	–	–	–	–	1.25	–	–	–	0.25
Mentha spicata	–	–	–	–	–	–	–	–	0.02	–	0.004	–
Cocculus carolinus	–	–	–	–	–	–	–	–	–	0.25	–	0.05
Quercus stellata*	–	–	–	–	–	–	–	–	0.05	–	0.01	–
Panicum obtusum	–	–	–	–	–	–	–	–	1.2	0.47	0.24	0.09
Conium maculatum	–	–	–	–	–	–	–	–	0.3	–	0.01	–
Rubus louisianus*	–	–	–	–	–	–	–	–	0.09	–	0.02	–
Quercus marilandica	–	–	–	–	–	–	–	–	0.02	–	0.004	–
Hymenopappus tenuifolius	–	–	–	–	–	–	–	–	–	0.03	–	0.01
Total Number of Species	32	31	49	42	27	29	57	45	55	48		
Economic Species No.	8	2	9	4	5	2	7	5	12	6		
%	9.73	1.03	9.41	2.27	0.57	0.86	9.33	4.83	14.26	14.65		

*Ethnographically known economic plants.
**AF – above floodplain; F – floodplain

Uniola latifolia (Broadleaf uniola) is very common on all five streams although it is more common above the floodplains on Medicine and East Cache creeks and on the floodplains along the other streams. This species is most common along Blue Beaver and Post Oak creeks, in contrast to the Carex sp.

Elymus sp. (Wild rye) is common above the floodplains of East Cache and Beef creeks.

Symphoricarpos obiculatus (Buckbrush) is quite common above all the floodplains except Post Oak Creek; it is absent or rare on the floodplains.

Rhus toxicodendron (Poison ivy). This species is common along

Table 6-7. Soil Survey
species represented in percentages

	GC	LM	RO	VED & VEC	ZAB & ZSB	KOC & KOB	LAB & LAC	WHB	FSB	LZD
Andropogon scoparius	38.6	12.4	31.0	30.5	45.8	27.2	37.6	15.8	27.8	40.4
Andropogon gerardi	0.2	1.0	0.8	7.9	6.6	1.0	–	1.4	0.2	25.8
Aristida sp.	9.4	5.6	5.4	3.6	9.2	15.0	6.2	20.4	14.2	2.0
Sporobolus sp.	4.4	10.6	2.8	15.2	1.6	10.4	9.2	5.6	6.6	3.6
Sorghastrum nutans	7.4	0.2	0.8	1.8	3.2	1.4	0.6	2.6	3.0	2.0
Bouteloua hirsuta	7.6	11.2	16.6	1.9	0.6	10.0	11.0	1.2	2.0	1.8
Bouteloua gracilis	0.8	3.2	1.0	2.4	9.2	0.2	–	1.2	1.2	2.8
Andropogon saccharoides	5.0	5.4	5.8	17.5	2.4	2.8	6.0	12.6	15.6	7.2
Artimisia ludoviciana var. ludoviciana	2.8	2.4	1.6	3.5	4.2	3.6	2.6	4.8	3.4	1.8
Chloris verticillata	0.4	0.2	0.2	0.5	1.6	0.4	1.4	–	0.8	–
Chrysopsis pilosa	0.2	1.6	1.8	–	–	–	0.4	2.6	–	–
Eragrostis sp.	2.4	0.2	2.6	1.3	1.2	6.4	8.4	6.2	3.4	0.6
Bromus tectorum	2.2	7.6	1.0	4.3	2.4	1.0	4.0	6.8	1.4	0.6
Panicum sp.	9.2	1.0	14.4	2.6	2.6	8.8	5.6	9.6	6.8	6.0
Artimisa glauca	0.6	1.0	2.6	0.8	–	0.2	0.6	1.0	0.4	0.2
Paronychia jamesii	2.0	2.4	1.0	0.6	0.2	–	0.4	0.2	–	0.2
Chrysopsis villosa var. villosa	0.2	0.4	0.6	–	–	0.2	0.2	–	–	–
Panicum virgatum	4.2	0.4	–	3.0	3.4	0.4	0.2	0.2	2.4	3.0
Baptisa sp.	0.4	–	–	–	–	–	–	–	0.2	0.2
Yucca glauca*	0.2	2.2	0.4	0.2	–	0.4	0.2	0.2	–	–
Opuntia compressa*	0.2	1.6	–	–	–	–	–	–	0.2	–
Sorghum halepense	0.2	–	–	0.6	0.2	1.0	0.6	4.0	1.8	–
Ratibida columnifera	0.2	–	0.2	0.2	–	0.4	–	0.8	–	–
Satureja arkansana	0.2	–	–	–	–	–	–	–	–	–
Muhlenbergia sp.	0.2	–	0.4	0.7	1.0	2.0	1.0	0.2	1.6	–

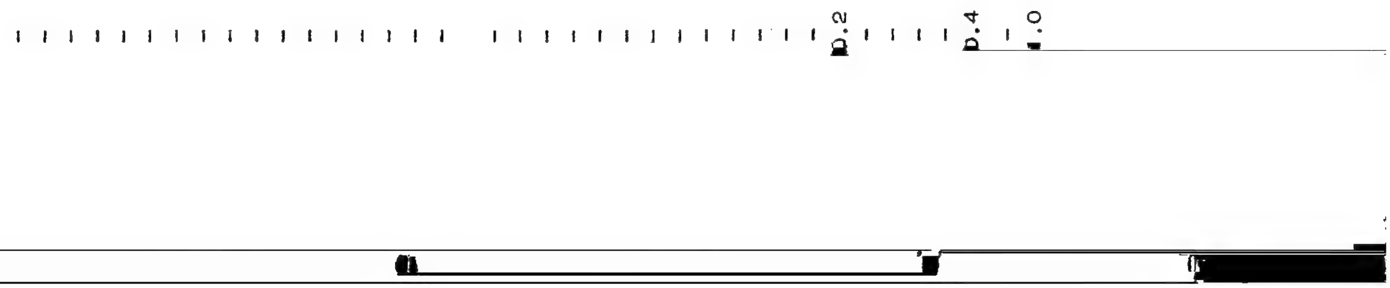

0.2
0.4
1.0

Table 6-7 Continued

Thelesperma filifolium	-	-	-	0.2	-	-	-	-	0.2	-
Achillea lanulosa	-	-	-	0.2	-	-	0.4	0.2	-	-
Hedyotis nigracans	-	-	-	-	0.8	-	-	-	-	-
Evolvulus nuttallianus	-	-	-	-	0.2	-	-	-	-	-
Liatris punctata*	-	-	-	-	0.2	-	-	-	-	-
Desmodium sp.	-	-	-	-	0.6	-	-	-	-	-
Agropyron smithii	-	-	-	-	0.2	-	-	-	-	-
Lespedeza sp.	-	-	-	-	0.2	-	-	-	-	-
Gnaphalium sp.	-	-	-	-	0.2	-	-	-	-	-
Bidens sp.	-	-	-	-	-	0.4	-	-	-	-
Myosotis sp.	-	-	-	-	-	0.2	-	-	-	-
Uniola latifolia	-	-	-	-	-	1.8	-	-	-	-
Alopecurus carolinianus	-	-	-	-	-	0.2	-	-	-	-
Andropogon virginicus	-	-	-	-	-	-	0.2	-	-	-
Eragrostis trichodes	-	-	-	-	-	-	-	0.8	-	-
Schrankia uncinata	-	-	-	-	-	-	-	-	0.2	-
Monarda sp.	-	-	-	-	-	-	-	-	0.4	-
Aster oblongifolius	-	-	-	-	-	-	-	-	-	0.4
Total Number of Species	27	39	44	29	29	31	28	27	27	20
Number Economic Species	2	4	5	2	2	3	2	2	2	0
Percent Economic Species	0.4	7.4	1.6	0.4	0.4	2.2	0.4	0.4	0.8	0

*Ethnographically known economic plants.

GC-Quanah
KOC
KOB -Quanah
WHB-Quanah

LM-West Range
RO-West Range
1/2 VEC & VED-West Range
LAB & LAC-West Range
FSB-West Range

LZD-East Range
1/2 VEC & VED-East Range
ZSB & ZAB-East Range

their different geologic and edaphic settings. Lucien soils have fewer species than any others (20) and are unique in that over 66% of all the vegetation consists of either little or big bluestem. Within the prairie soils, however, modern disturbances should be kept in mind when interpreting differences in the local vegetation. Overall, the prairie soils are quite similar with respect to the dominant species represented, despite noticeable differences in the exact frequencies in the samples.

Table 6-8. Dominant species of plants by soil type represented in percentages.

	GC	LM	RO	VED & VEC	ZAB & ZSB	KOC & KOB	LAB & LAC	WHB	FSB	LZD
Andropogon scoparius	38.6	12.4	31.0	30.5	45.8	27.2	37.6	15.8	27.8	40.4
Andropogon gerardi	0.2	1.0	0.8	7.9	6.6	1.0	-	1.4	0.2	25.8
Aristida sp.	9.4	5.6	5.4	3.6	9.2	15.0	6.2	20.4	14.2	2.0
Sporobolus sp.	4.4	10.6	2.8	15.2	1.6	10.4	9.2	5.6	6.6	3.6
Bouteloua hirsuta	7.6	11.2	16.6	1.9	0.6	10.0	11.0	1.2	2.0	1.8
Bouteloua gracilis	0.8	3.2	1.0	2.4	9.2	0.2	-	1.2	1.2	2.8
Andropogon saccharoides	5.0	5.4	5.8	17.5	2.4	2.8	6.0	12.6	15.6	7.2
Panicum sp.	9.2	1.0	14.4	2.6	2.6	8.8	5.6	9.6	6.8	6.0
Lolium perenne	-	11.0	0.8	-	-	-	-	-	-	-
Eragrostis sp.	2.4	0.2	2.6	1.3	1.2	6.4	8.4	6.2	3.4	0.6
Bromus tectorum	2.2	7.6	1.0	4.3	2.4	1.0	4.0	6.8	1.4	0.6
Total %	79.8	69.2	82.2	87.2	81.6	82.8	88.0	90.8	79.2	90.8

various subdominants would appear in large numbers in isolated soil types. Andropogon gerardi occurred significantly in Lucien Zanies Vernon Complex (LZD) soils, but was rather insignificant in all the others. Aristida sp., Sporobolus sp., Bouteloua hirsuta, Andropogon saccharoides, and Panicum sp. also fell into this pattern of occurance.

The undergrowth study revealed a massive list of 125 different species, and of these only a few occurred in low, but still significant numbers. Carex sp. and Uniola latifolia have average percentage compositions of between 10% to 12% (Table 6-6) for above the floodplain counts. Overall, the undergrowth study revealed great diversity of plant species, with very little dominancy of any given specie.

Chapter 7

RECONNAISSANCE SAMPLING AT FORT SILL:

Probability theory enters the problem with the concern for controlling data. Probability theory offers the solution to the essential problem of evaluating the chance that differences observed in quantitative data reflect chance or accident, rather than real differences in the data themselves. For more adequate descriptions of probability sampling the reader is referred to Slonim (1960) and Cochran (1963). The first of these is a more simplified introduction while the second is a more thorough text.

As Mueller (1975:ix) has pointed out, archaeologists have been sampling in the broadest sense of the term (implying substitution) since the beginnings of the discipline. During the course of any archaeological project an investigator is constantly confronted with situations in which he can study only a portion of a total universe of possibilities. Traditionally, archaeologists faced with choices have made intuitively based selections of archaeological data. Such a

procedures, which may be based on particular sampling techniques, in order to accomplish more accurate descriptions and more purposeful and valid inferences in line with theoretical or other aims.

The rest of this "sampling overview" will be devoted to presenting explications of sampling methodologies in order to establish a framework for the understanding and evaluation of the methodologies applied in the course of this research. Towards this end, this overview section will proceed through definition of some sampling terms, and their empirical correlates, present some descriptions of key aspects of sampling techniques and then discuss three related problems in the actual implementation of sampling formulas and discuss separate approaches developed in treating levels of sampling and analysis in archaeology. Lastly, a brief discussion is offered concerning the organizational principles utilized in structuring the relationships between different sampling formulas in the implementation of multi-stage research.

Empirical Correlates for Sampling Terms

Terminology in sampling formulas and the things in the real world which are the empirical correlates for the terms must be clearly established. Both sampling terms and their empirical correlates are defined in the following section, and will be illustrated as they exist in a hierarchial order, as based on Chenhall (1975:6-9).

A universe will be defined as an aggregate of phenomena which a researcher is trying to assess or explain. Following Chenhall (1975: 12) and secondarily an example provided by Hackenberger and Cheek (1976) the empirical correlate of the "universe" being assessed will be treated as the aggregate of cultural responses, or activities in the

within the boundaries of the Fort Sill Military Reservation, and outside the boundaries of the fort's four impact areas. These sample units were derived from the Universal Transverse Mercator grid system which has been previously imposed and utilized by the U.S. Army.

A stratum will be defined as a subset of elements belonging to the target population. The target population as a set of spatial units can also be defined or classified along several dimensions represented by environmental variables associated with individual sample units. These dimensions can then be used to select sample units and to infer to the universe. Specific strata recognized in the present research will be presented with further descriptions of each specific sampling formula implemented in the sampling of Fort Sill.

Within a classification perspective as presented by Dunnel (1968) the various intersections of variable dimensions (represented by spatial co-occurrences of particular environmental variables within individual sample units) exist as classes within a paradigmatic classification of an observational population. Within the present terminology such classes are recognized as strata. The exact nature of several strata will be presented along with the variable dimensions used in

A sample population will be defined as the subset of the target population about which information is gathered. The target population is necessarily inferred from a sample population. Under the last three implemented sampling formulas, the empirical correlate of the sample population simply represents the units selected within each sampling formula from each class or stratum of each target population. Sample populations were created through selecting individual sample units through the use of a table of random numbers from lists of sample units, termed sample frames, for each stratum of each target population. Sample populations consist of varying numbers of units and represent disproportional samples of the total number of units within each strata.

Aspects of Sampling Design

Apart from both sampling terminology and the definition of empirical correlates for such terms, several specific sampling techniques and problems must be described in order to relate the use of specific formula in the survey of Fort Sill. Although many sampling techniques exist, or can be constructed through the combination of these techniques, four basic design aspects will be discussed below. These include: judgment sampling, simple random sampling, systematic sampling, and stratified random sampling. These design aspects have not been used singularly as they are described, but have been used within "composite" sampling formulae which were actually implemented and which will be described below. Related problems which must be discussed in regard to sampling techniques include sample unit shape, sample unit size, and sample sizes.

Judgement sampling is a technique consisting of simple selections of sample elements on particular criteria, without probability sampling. The purposes of such a technique may be varied, and although this technique often amounts to traditionally applied intuitive sampling, its use is necessarily encountered in cultural resource management where archaeologists are often sampling areas because of factors related to proposed land use activities. At the onset of the Fort Sill archaeological survey, the first sampling phase was a judgment based sample which involved surveying a number of areas of proposed building construction, borrow activity areas, and sites of proposed range pond construction.

Simple random sampling is the most basic aspect of probability sampling and as such is a technique of selection in which every member of the population has exactly the same chance (probability) of being

included in a sample. Toward this end, it is imperative that both sample units and the sample frame are clearly defined. In simple terms, the purpose of this technique is to achieve a sample which may be considered "free" of bias which may be inherent in other non-probability based samples.

A basic procedure involved in selecting a simple random sample can involve listing the total number of units in a sample frame, numbering them serially, and then selecting random numbers which correspond to numbers of the sample frame from a table of random numbers.

As long as a population or sub-population is assumed to be homogeneous, and all individuals in a population or sub-population are equally accessible, simple random sampling is a standard procedure used singularly or in combination with other techniques for estimating population means and variances (Ragir 1972:183).

Systematic sampling is a technique which accomplishes an even spread of sample units over an area to be sampled. Usually a single unit is randomly selected, that is with each unit having an equal chance of being selected, with subsequent units then being selected at previously determined intervals. Discussions concerning this technique and related probability problems, as well as practical problems involving definition of patterns, occur consistently within the archaeological literature cited above. (Systematic samples of the six major streams at Ft. Sill were employed to achieve the minimum one-third survey of those areas as stipulated by the scope-of-work.)

Stratified sampling is a technique of controlled sampling in which judgment is exercised in the selection of samples through the recognition of two or more sampling strata. The strata are defined on the presence of one or more attributes. This procedure generally involves selecting simple random samples from each stratum. The purpose of stratification is to insure that sampling units are selected from each stratum, and therefore, the full recognizable variability which may exist within a target population can be represented in the sample.

Overall, stratified samples yield better estimates of the population means and variances than do simple random sampling, because the variability in each sampling stratum is taken into account in setting confidence limits on population means (Ragir, 1972:184).

Strata as previously discussed may be constructed through either spatial divisions or divisions based on variable character or relationships. The first usage will essentially accomplish aims similar to

those of a systematic sample and spatially spread samples, while the second use may accomplish selection of 1) units belonging to classes recognized through divisions of a single large scale variable (i.e., environmental zones), or 2) units belonging to classes recognized through the intersection of two or more specific variables (i.e., co-occurrences of two or more specific environmental variables with a sample unit).

In regard to stratified sampling, sampling fractions must be mentioned. Just as total sample size will be discussed as a sampling problem below, sample sizes for each strata of a stratified sample must also be discussed. Two types of stratified sampling schemes are recognized based on sampling fractions. Very simply "disproportional" stratified schemes involve the sampling of unequal percentages of each recognized strata and "proportional" stratified schemes involve the sampling of equal percentages of each recognized strata. In regard to these points, the selection of equal numbers of units from strata of unequal numbers of units represents a disproportional sample.

Disproportional samplings have been used throughout most sampling formulas implemented in the survey of Fort Sill. The author disputes Mueller's (1972:50) conclusions that this sampling scheme seems unacceptable. These objections will be briefly presented here in order to justify the use and reevaluation of disproportional stratified sampling. The author's main objections stem from the fact that Mueller's methodologies, aims, and evaluative conclusions have been restricted to testing results of samples compared to total known populations and do not involve comparisons between strata, the more usual purpose of collecting stratified samples. Mueller's comparisons were based on a particularly inappropriate test statistic. the chi square test, using absolute frequencies and not measures of populations means and variances which, as previously stated, are not only more typically used with analyses of stratified samples, but are the main advantage of stratified samples. Mueller's results are based on a "local" variable (zone) which has been used as the means of constructing strata. Most surely differences between sample estimates and total population parameters will indeed confront a researcher if relative portions of each strata sampled are not accounted for, which his chi square analyses are unable to do.

Necessary sample size can be specified but never out of context of the degree of certainty a researcher desires, as well as the sampling technique used of the characteristics of the population being sampled. Debate over the virtues of 10%, 20%, 50% or 100% samples

are in abstract, uninformative. There is no such magic number. That is, there may be no magic number outside a figure specified in a contractual agreement. In the case of the present survey, the total sample size is limited to about 18% of Fort Sill's total land area. Here, however, the problem of sample size and reasoning of solutions for the problem has been of major concern.

At least one major set of alternatives for determining appropriate sample sizes exists for cases where samples are used in testing hypotheses. These alternatives involve testing the sample size used. That is, tests are achieved to see whether or not sample sizes are sufficient to reject or accept null hypotheses being tested.

These procedures usually involve sequential sampling, which [illegible]

There are four general types of units employed in spatial sampling. These include points, quadrats, transects and circles. For the purposes of the Fort Sill survey, two types of these units, quadrats and transects, have been utilized.

The most generally used sampling units for areal problems are the quadrat and the transect. Recently, researchers interested in the relative efficiency of these two types of units have concluded that transects are in general more "efficient" than quadrats involving predictions of site locations, their density and some of their larger scale attributes (Mueller, 1974; Plog, 1976; Judge, Ebert and Hitchcock, 1975). These conclusions have, however, been drawn from results of simple random samples, or stratified random samples, based solely on spatial divisions and/or broad stratifications based on environmental zones. Subsequently, these studies have ignored the possible adequacy of each of these two types of samples units for other sampling schemes, and in particular, sampling schemes based on stratifications or classifications in turn based on variable interactions of specific environmental variables which may be realized as micro-environments at the level of individual sample units.

In regard to such a sampling endeavor as the latter case just described, it has in fact been concluded that transect units seem inappropriate for the characterization of limited micro-environments recognized on the basis of variable intersections simply due to their sprawling nature. Quadrats, however, seem more capable of representing limited areas in which variable intersections more often occur (Hackenberger and Cheek, 1976; Stewart, Cheek and Hackenberger, 1977).

All in all, sample unit shape still remains dependent on the purposes of a sampling formula, and as will be seen through the present research each will be employed for the separate purposes which they best fit.

Sample Unit Size

Whatever the shape of sample units, they should be kept approximately equal size or some form of keeping tabs on the total sample sizes and resulting probabilities must be present.

Smaller sample units have been said to yield more "accurate" results, for a constant proportion of the total population, because the smaller the unit the larger the absolute size of the number of units to be investigated (Plog, 1976; Redman, 1974). There are, however, a number of reasons for not making sampling units excessively small.

First, each unit must yield sufficient data for analyses. Second, the smaller the unit the more difficulty there is in locating and investigating a large number of them. Third, the smaller a sample unit the more the practical difficulty arises in determining whether each phenomenon being observed falls inside or outside a particular sample unit (Redman, 1974:19).

In the end then, the major advantage of smaller sample units must be weighed against the three above disadvantages of smaller units.

Multistage Field Work and Intermediate Analytical Techniques

This following discussion pertains to a set of organizational principles that have been used to structure the combined use of several different sampling formulas. Statements in regard to these principles will be valuable in elucidating organizational principles behind the overall methodological structure of the survey of Fort Sill.

[illegible]

investigations of smaller, or recharacterized portions of a target population. By following successive stages of sampling, preliminary results from earlier samples help redefine a target population and the proportion of the target population to be sampled.

Sample Stages

The following outline presents descriptions of the techniques and

ge I: stream survey

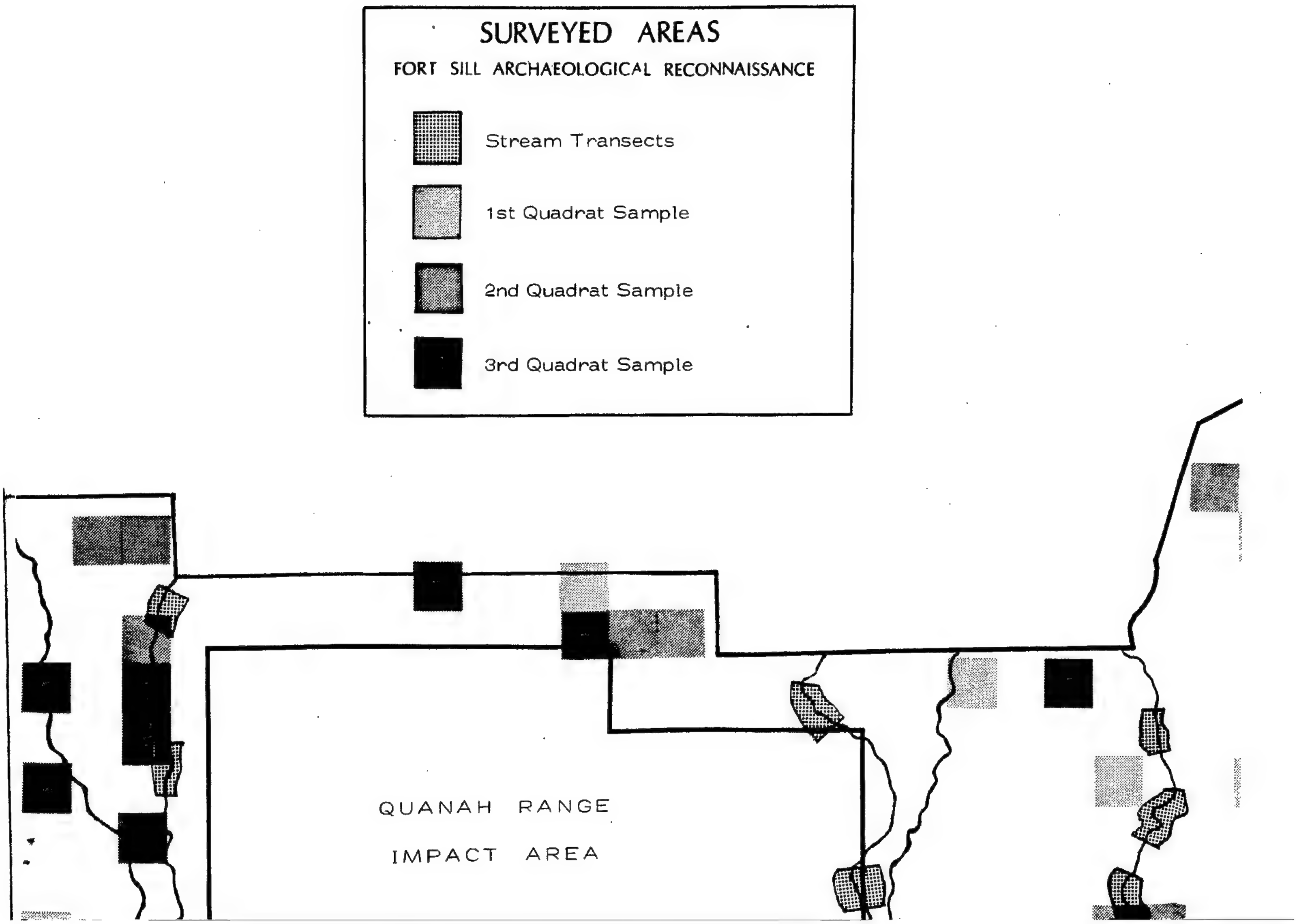
Crater		West Cache		Post Oak	
ea (km)	Sites	Area (sq km)	Sites	Area (sq km)	Sites
2	---	.163	FSS 33	.151	FSS 14
			FSS 34		FSS 15
					FSS 16
1	---	.459	---	.180	FSS 24
					FSS 84
.0	---	.203	FSS 32	.312	---
3	FSS 70	.189	FSS 59	.175	FSS 21
			FSS 61		
.	---	--	---	.172	---
.	---	--	---	--	---
.	---	--	---	--	---
.	---	--	---	--	---
.	---	--	---	--	---
.	---	--	---	--	---
6	1	1.014	5	.990	6
1.65		4.93		6.06	

Strata were generally recognized on the basis of broad topographic, hydrographic and gross vegetational features along each of these creeks, and were used to distribute the sampling of each of the creeks accordingly. These stratifications were based on examination of standard 7.5 minute U.S. Geological Survey quad sheets of the reservation, and were accomplished before ancillary studies were completed describing the streams' vegetational and geomorphological features. Thus the stratifications of the stream areas are described here as they were initially perceived and completed. Resulting stratifications, as well as the shapes and sizes of sampling units, are presented in Map 5, and will be discussed creek by creek. Sample units were drawn on field maps, and were used in actually surveying the major streams. For more detailed geomorphical description of these stream courses and their terraces see Hall (this volume).

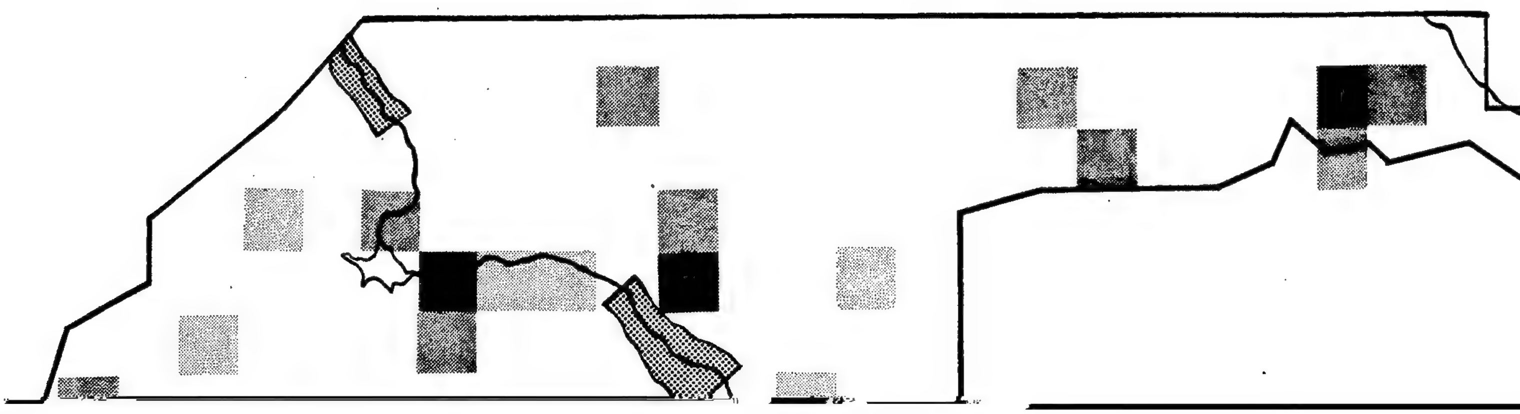
East Cache Creek was not stratified, but was systematically sampled. A set of transects was arranged perpendicular to the stream's course (Map 6) each 0.33 km in width and the width of this stream valley in length. Transects were sampled by selecting a random number between one and three, representing the first three transects of the system, and then every third transect after the first selected transect was also selected for survey. A total of seven transects were surveyed across the valley of East Cache Creek. This method differed from the transect surveys of the other stream courses because of the extreme width of this stream's floodplain and the meandering course of this stream.

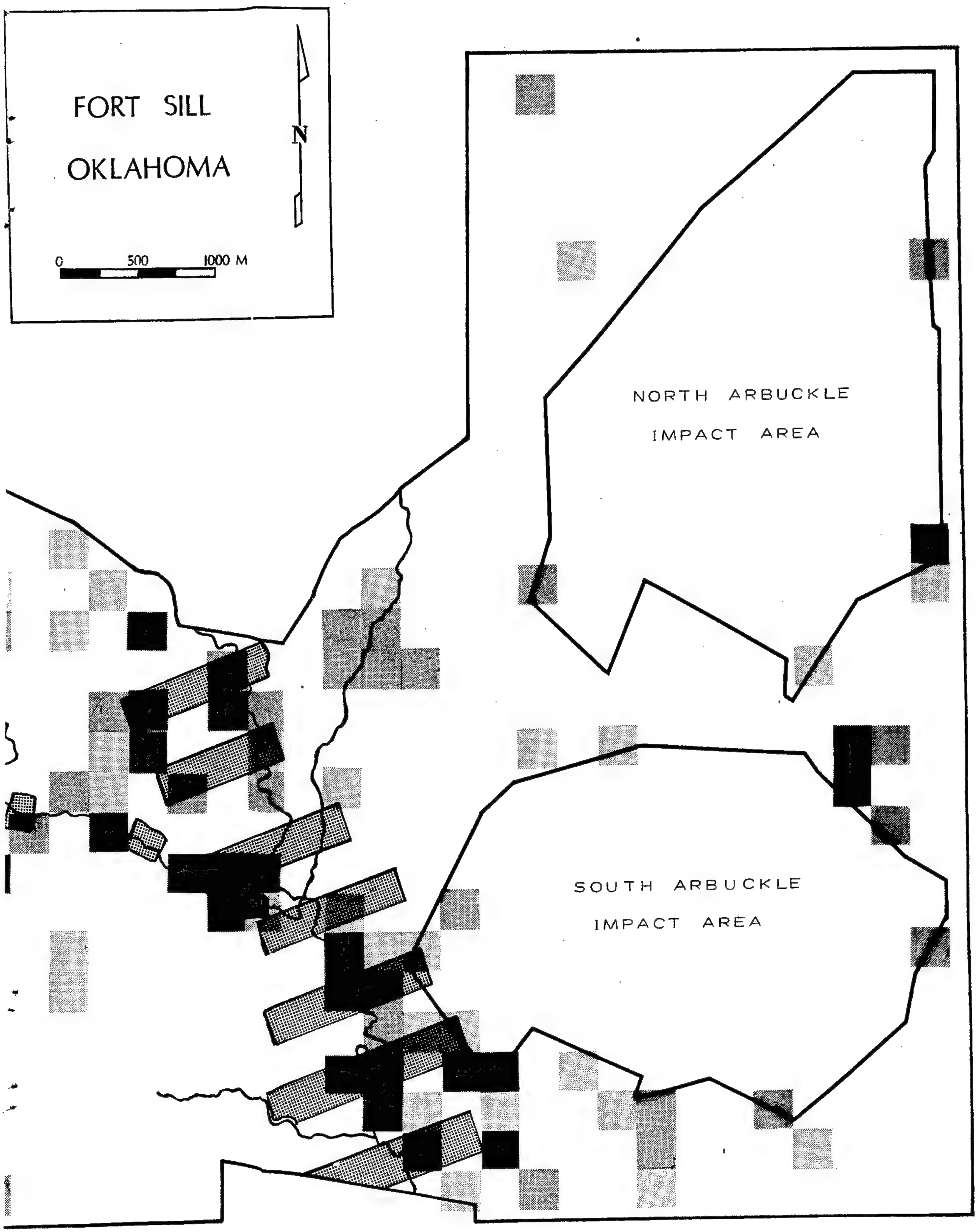
Medicine Creek was divided into three major strata based on topographic features following the stream course. The first stratum consists roughly of the first 4.5 km of the creek as it enters the reservation from the north. This area is generally characterized by steep boulder-strewn hill slopes on the south bank of the creek and more open high terraces and small rolling prairie areas on the north bank. The second stratum consists of the next 4.5 km portion of the creek, which is characterized by mountain and hill slope areas which alternately occur on both sides of the creek. The third stratum consists of the last 4.5 km of Medicine Creek to the point of its confluence with East Cache Creek. This stratum is characterized by heavily wooded, broad floodplain areas on each side of the creek.

Nine 0.5 kilometer-wide transect units exist in each stratum. Therefore, after the first randomly selected transect out of the first


SURVEYED AREAS
FORT SILL ARCHAEOLOGICAL RECONNAISSANCE
Stream Transects
1st Quadrat Sample
2nd Quadrat Sample
3rd Quadrat Sample
QUANAH RANGE
IMPACT AREA

MAP 6




FORT SILL
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500
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SOUTH ARBUCKLE
IMPACT AREA

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three transects was selected, every third transect was chosen along the entire length of this creek. A total of nine sample units was selected and surveyed.

Blue Beaver Creek was also divided into three major strata based on broad topographic patterns. The first stratum consists approximately of the first 4.0 km of the creek as it enters the reservation from the north. This area is generally characterized by the creek's constricted nature as it flows between sheer faces or steep slopes of granite. The second stratum consists roughly of the next 6.0 km of the creek, an area where the floodplain expands somewhat [illegible]

West Goose Creek was divided into three strata based on

Stream Survey Results

Results of the stream surveys show differential site densities across the major streams of the Fort, as well as concentrations of sites in particular areas along these streams (Table 7-1). Post Oak, Medicine, Blue Beaver and West Cache creeks all have relatively high site densities, while East Cache and Crater creeks have lower site densities. Concentrations of sites were particularly observed in the southern-most transects on East Cache, in the fourth and seventh transects on Medicine Creek, in the second and fourth transects on Blue Beaver Creek, in the first and fourth transects on West Cache, and in the northern-most transect on Post Oak Creek.

Sample Stage III: Quadrat Surveys

The third sampling stage of the Fort Sill Reconnaissance actually consisted of three separate but related stratified quadrat samples. This stage of sampling represents the bulk of the survey conducted and the most rigorous portion of the survey research oriented towards the location and prediction of archaeological sites. The purpose of this phase of sampling was to achieve a valid sample of the entire reservation area (exclusive of the impact areas). This sampling stage also was designed to investigate the spatial relationships between environmental variables such as geology, soils and hydrology, and archaeological resources. A total coverage of at least 15% was sought in this phase of sampling despite the previous areas coverage. Multiple sample phases were employed in order to improve the amount of feedback between investigations of the separate stratifying variables and also to allow refinement of the sampling strategy during the course of the reconnaissance. The last sample, in fact, constituted an application of the predictive aspects of the first two sample phases implemented to maximize the discovery of sites.

As stated in the introduction, the selection of the three separate quadrat samples was a related process. In fact, this sampling stage, and the relationship of the three sample phases, represents the most rigorous application of the previously described principles of multistage field work and intermediate analytical techniques. Each of these samples is based on separate stratifications, yet the environmental variables used in the stratification are repreated in a complementary fashion.

Within each set of stratifications, specific measureable and potentially relevant environmental variables were sought and used. For each set of samples, the reservation was first stratified by drawing boundaries of geological units from which quadrats were sampled.

These geological units were established by following and approximating the spatial boundaries of large scale geological formations present on the reservation. These large scale stratifications of the reservation were used not only because of previously defined relationships between geology, soils and vegetation (Buck, 1964; Crockett, 1964), but also because such stratification allows a means of achieving a more even distribution of sample units over the reservation.

Quadrats were chosen as the sample unit type, because of factors pertaining to the spatial treatment of specific environmental situations which were recognized through treating co-occurrences or relationships between specific environmental variables at the level of individual sample units. Sample quadrats, 500 m^2 (.25 sq km) in size were used for all three sample stages after weighing the advantages and disadvantages of other small sample unit sizes.

One further point can be added here in regard to the use of quadrats over transects in sampling the reservation. Transects are best used, as on East Cache Creek, to provide cross sections of linear trending environments. Their use across large regions without any such linear trend would be more awkward.

Quadrat Sample 1: Soil Variables

The first quadrat sample proceeded from the large scale stratification of the reservation to further stratifications of the populations of quadrats in each of the geological strata on the basis of two soil variables: the dominant soil type in the unit-that is, the soil type with the greatest area in an individual quadrat, and soil complexity-the number of soils which occurred in an individual quadrat.

Soil variables were measured through the use of a map of "lumped" soil types, or soil associations (Map 2) which was prepared from a SCS map (Mobley and Brinlee, 1967) of soil types present on the reservation. Actual percentages in each of 1061 individual quadrats were calculated through laboriously counting dots layed over soil areas, using a tight pattern of "Zipatone" dots (sheet 314, 20 percent). Row counts for each soil type were coded and

punched on computer cards for each quadrat. Given the relatively small sample, soil complexity measurements had to be collapsed into two groups for the purpose of stratification. These groups were: 1) one or two soil types present and 2) three or more soil types present.

These soil variables were used as they are assumed to represent polythetic sets of environmental variables, involving relationships between such variables as soil type and complexity with biotic factors. The elucidation of such relationships have been goals of the project's ancillary studies. Soil dominants are assumed to have the greatest affect on the distribution of resources and potentially, therefore, of archaeological sites. It is expected that the juxtaposition of soil types within a specific area also affects resource availability.

Phase I of the quadrat survey resulted in the coverage of 93 quadrats or 23.25 sq km (Table 7-2). The sampled units included approximately equal coverage of simple and complex quadrats. Portions of types of quadrats based on soil dominant varied since equal sized samples were not feasible given the areal coverage desired. The percentage figures actually varied from about 3.5% to about 25% of any given soil dominant group. When actual areas of each soil dominant are considered it is apparent that between about 4% and 15% of the area of any given soil association was surveyed in the first quadrat sample.

Subsequent samples based on non-soil stratifications are of course important nonetheless in evaluating soil association-site relationships. When all three sample stages are considered, it may be seen that between 8.9% and 39.72% of the actual areas of the soil associations was surveyed during the entire quadrat sampling stage (Table 7-3). This amounted to an average soil association coverage of 20.20%.

Quadrat Sample 2: Hydrological Variables

The second quadrat sample involved a further stratification of the population of each geological strata on the basis of a hydrological classification of the stream courses represented on U.S.G.S. 7.5 minute quad sheets of the reservation (Map 4). The hydrological classification of stream courses was taken from Weide and Weide (1973). Basically, the system recognizes higher order stream courses (lower numbered) developing into lower order (higher numbered) stream courses after the confluence of only two similarly

Table 7-2. Sampling grid for soil quadrats stratified by dominant association and soil complexity.

Dominant Soil Association:	Alluvium	Granite Cobbly	Foard	Lawton	Limestone Cobbly	Lucien	Rocky-Stony	Vernon	Windthorst-Konawa	Zaneis	Total Quadrats	Area (sq km)
Low Soil Complexity												
Unsampled	61	54	132	6	3	38	135	24	–	139	592	148.00
Quadrat Sample I	6	5	10	2	1	2	10	4	–	5	45	11.25
II	8	5	6	2	–	3	10	3	–	5	42	10.50
III	12	8	–	–	–	–	–	11	–	–	31	7.75
Total No.	87	72	148	10	4	43	155	42	–	149	710	177.50
%	12.3	10.1	20.8	1.4	.6	6.1	21.8	5.9	–	21.0		
High Soil Complexity												
Unsampled	51	49	71	16	–	5	34	12	8	7	253	63.25
Quadrat Sample I	11	10	11	5	–	1	3	4	1	2	48	12.00
II	10	4	9	1	–	1	2	2	–	2	31	7.75

Table 7-2. (Continued)

Dominant Soil Association:	Alluvium	Granite Cobbly	Foard	Lawton	Limestone Cobbly	Lucien	Rocky-Stony	Vernon	Windthorst-Konawa	Zaneis	Total Quadrats	Area (sq km)
Quadrat Sample III	6	7	-	-	-	-	-	6	-	-	19	4.75
Total No.	73	70	91	22	-	7	39	24	9	11	351	87.75
%	22.2	19.9	25.9	6.3	-	2.0	11.1	6.8	2.6	3.1		
Grand Total No.	160	142	239	32	4	50	194	66	9	160	1061	265.25
Grand Total %	15.0	13.3	22.5	3.0	.3	4.7	18.3	6.2	.8	15.1		
Percent Surveyed	33.1	27.4	15.0	31.2	25.0	14.0	12.9	45.4	11.1	8.7		

Table 7-3. Areal and percentage coverage of soil associations during quadrat sampling stage.

Soil Association	Quadrat Phase Coverage (sq km)			Total Coverage		Total Area	
	I	II	III	sq km	%	sq km	%
Alluvium	4.15	4.15	4.78	13.08	30.03	43.55	16.25
Granite Cobbly	3.15	2.65	2.95	8.75	23.86	36.67	13.69
Foard	4.55	3.30	.59	8.44	15.53	54.33	20.28
Lawton	1.86	.86	.54	3.26	29.15	11.18	4.17
Limestone Cobbley	.41	.004	.00	.414	28.55	1.45	.54
Lucien	.97	1.16	.09	2.22	15.63	14.20	5.30
Rocky-Stoney	3.41	2.94	.40	6.75	13.82	48.82	18.22
Vernon	2.76	1.22	2.92	6.90	39.72	17.37	6.48
Windthorst-Konawa	.29	.15	.00	.44	19.38	2.27	.84
Zaneis	1.52	1.65	.22	3.39	8.90	38.05	14.20
Total Area (sq km)	23.07	18.084	12.49	53.644		267.89	

first-order streams meet the stream course developed below their confluence becomes a second-order stream. This stream rank remains unchanged until another second-order stream intersects it

survey. Table 7-4 presents crosstabulations of the number of units surveyed of each hydrological type under quadrat samples 1, 2 and 3.

After the selection of the second quadrat sample, it was restratified on the basis of the soil variables used in quadrat sample 1 (Tables 7-2, 7-3). This showed that between 0.0 and 20.0% of soil-classed units were surveyed in quadrat sample 2. These combined populations of quadrat samples 1 and 2 were used to evaluate the

Table 7-4. Character of quadrats with respect to hydrographic attributes and all quadrat sampling phase results.*

STREAM COMPLEXITY	DOMINANT STREAM RANK 0 no streams	1 first or second order	2 third or fourth order	3 fifth or greater order	Total %	% sampled
0 no streams	126 (11.9) 11 (8.7)				11.9	8.7
1 one or two streams		415 (39.1) 59 (14.2)	109 (10.2) 24 (22.0)	63 (5.9) 27 (42.9)	55.2	18.7
2 three or four streams		164 (15.5) 28 (17.1)	93 (8.8) 30 (32.2)	14 (1.3) 11 (78.6)	25.6	25.5
3 five or more streams		27 (2.5) 10 (37.0)	46 (4.3) 16 (34.8)	4 (0.4) 2 (50.0)	7.2	36.4
Total %	11.9	57.1	23.3	7.6		
% sampled	8.7	16.0	28.2	49.4		

*Upper figure refers to total number of quadrats in specified class followed by percentage in parentheses. Next lower figure indicates number and percentage of quadrats surveyed.

Table 7-5. Comparison of three quadrat samples with respect to coverage of quadrat hydrographic attributes.

Dominant Stream Rank:	0 no stream	1 1st or 2nd	2 3rd or 4th	3 5th or greater	Total
Unsampled	115	509.	180	41	845
Quadrat Sample					
I	7	53	26	7	93
II	4	27	27	15	73
III	–	17	15	18	50
Total Quadrats	126	606	248	81	1061
Percent Surveyed	8.7	16.0	27.4	49.4	20.4

Stream Complexity	0 no stream	1 1–2 streams	2 3–4 streams	3 5 or more streams	
Unsampled	69	497.	220	59	845
Quadrat Sample					
I	7	52	25	9	93
II	4	26	27	16	73
III	–	30	17	3	50
Total Quadrats	80	605	289	87	1061
Percent Surveyed	13.8	17.9	23.9	32.2	20.4

Results of the Quadrat Sample Analyses

The following section presents results of analyses completed within outlined procedures of the three quadrat samplings. These [illegible] evaluations on tests of the effects and

Table 7-6. Site frequencies by soil dominant in quadrat sample phase. Blanks indicate category unsurveyed.

	Quadrat Sample Stage								
	I			II			III		
Soil Dominant	n	x	sd	n	x	sd	n	x	sd
1. Alluvium	8	.47	.80	6	.33	.59	14	.78	1.00
2. Granite Cobbly	7	.46	.74	3	.33	.70	11	.73	.79
3. Foard	3	.14	.36	1	.06	.25			
4. Lawton	1	.14	.37	3	1.00	1.00			
5. Limestone Cobbly	0			0					
6. Lucien	1	.33	.57						
7. Rocky-Stony	0			2	.16	.39			
8. Vernon	4	.50	.53	2	.40	.54	8	.47	.51
9. Windthorst-Konawa	0								
10. Zaneis	0			1	.14	.37			
Number of Quadrats		93			73			50	

Table 7-7 presents results of a two-way analysis of variance on sample stage 1. The results of this analysis suggest, if a traditional significance level of .05 is accepted, that there are no overall effects

Table 7-7. Analysis of variance: soil dominant and soil complexity, quadrat phase I.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.280	9	.031	1.880	.109	
Soil Dominant	.279	8	.035	1.888	.074	.39
Soil Complexity	.017	1	.017	.903	.345	.10
2-Way Interactions	.266	7	.038	2.058	.059	
Soil Dominant/ Soil Complexity	.266	7	.038	2.058	.059	
Explained	.546	16	.034	1.845	.040	
Residual	1.387	75	.018			
Total	1.933	91	.021			

Multiple R = .387

significant differences can be concluded for site densities between soil complexities of alluvial soil-dominated quadrats and Lawton-dominated soils. In each case, site densities are suggested to be the highest in situations with low soil complexity.

Quadrat Sample 2

Breakdowns of the means, standard deviations, and variances for each type of quadrat present in quadrat sample 1 based on the hydrological stratification proposed for use in quadrat sample 2 show overall increasing frequencies of sites as dominant stream rank increases (Table 7-8).

Table 7-9 presents a two-way analysis of variance in which both

Table 7-8. Site frequencies by hydrological attributes of quadrats in quadrat sample 1.

Dominant Stream Rank		Number of Streams: 0	1-2	3-4	5	Total
0	x	.14				.14
	sd	.38				.38
1-2	x		.08	.27	.25	.13
	sd		.27	.47	.50	.34
3-4	x		.30	.36	.20	.30
	sd		.48	.81	.44	.62
5	x		.50	2.00		1.14
	sd		.57	0.00		.90

Grand mean = .26
sd = .55

Table 7-9. Two-way analysis of variance of hydrologic factors on site frequencies in quadrat sample 1.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.470	3	.157	10.093	.001	
Domstr	.347	2	.174	11.186	.001	.45
Numstr	.070	1	.070	4.493	.038	.21
2-Way Interactions	.142	2	.071	4.585	.013	
Domstr Numstr	.142	2	.071	4.585	.013	
Explained	.612	5	.122	7.889	.001	
Residual	1.102	71	.016			
Total	1.714	76	.023			

Multiple R = .524
Multiple R^2 = .274

These results for quadrat sample 1 led to the sampling design for the second quadrat sample. The latter was thus based on the suggested relationships between site frequencies and hydrological variables observed in the first quadrat sample.

Table 7-10 presents breakdowns of means, standard deviations, and variances for a number of sites by types of hydrological quadrats in the second sample. This table again shows increasing overall means as dominant stream rank increases. However, the means are both lower and increase less dramatically in this sample compared to sample 1.

Table 7-10. Site frequencies by hydrological attributes of quadrats in quadrat sample 2.

		Number of Streams				
		0	1-2	3-4	5	Total
0	x	.50				.50
	sd	.58				.58
1-2	x		.09	.10	.16	.11
	sd		.30	.32	.41	.32
3-4	x		.25	.18	.25	.22
	sd		.46	.60	.46	.51
5	x		.71		1.00	.46
	sd		.95		0.00	.74

Grand mean = .24
sd = .52

A two-way analysis of variance (Table 7-11) for the second quadrat sample suggests that, with the traditional .05 level of significance, there were no significant effects of either of the two hydrological variables or their interactions, but that 32.9% of the variance in site density was explained by the hydrological variables. Note the relatively low significance of dominant stream rank (.097) suggesting some support for the first quadrat sample results.

Two three-way analyses of variances were run to test the differences between the results in sample 1 and sample 2 with regard to hydrological factors and site frequencies.

Table 7-11. Two-way analysis of variance of hydrologic factors on site frequencies in quadrat sample 2.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.141	4	.035	2.041	.100	
Domstr	.084	2	.042	2.429	.097	.26
Numstr	.062	2	.031	1.803	.174	.22
2-Way Interactions	.123	4	.031	1.772	.146	
Domstr Numstr	.123	4	.031	1.772	.146	
Explained	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	

Table 7-12. Analysis of variance of hydrologic factors and quadrat sample on site frequencies for quadrat samples 1 and 2.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.322	4	.083	5.081	.001	
Domstr	.304	2	.152	9.303	.001	.35
Numstr	.007	1	.007	.425	.516	.05
Sample	.064	1	.064	3.934	.050	.16
2-Way Interactions	.235	5	.047	2.879	.017	
Domstr Numstr	.011	2	.006	.342	.711	
Domstr Sample	.113	2	.057	3.471	.034	
Numstr Sample	.098	1	.098	5.979	.016	
3-Way Interactions	.201	2	.100	6.145	.003	
Explained	.769	11	.070	4.274	.001	
Residual	1.929	118	.016			
Total	2.698	129	.021			

Multiple R = .351
Multiple R^2 = .123

overall mean site frequency for dominant stream rank group 3 is 1.14, while in Table 7-10 it is only 0.46. Also, in Table 7-8 the mean for dominant stream rank group 3 – number of stream rank 2 is very high 2.00, with only three such units surveyed, whereas in Table 7-10 the mean is zero with six such units surveyed. So in regard to the third level of dominant stream and particularly its co-occurrence with one extra stream course, there is an inconsistency represented between quadrat samples 1 and 2.

As stated previously the quadrat sample 2 was also restratified with the soil variables used in quadrat sample 1. The results of mean, standard deviations, and variances for the site frequencies are broken down across quadrat types in Table 7-6. Means are generally lower in this table than they were for quadrat sample 1, broken down by soil variables. The general trend for high means for soil types 1, 2, and 8 holds in tables for both quadrat samples

Table 7-13. Analysis of variance for hydrologic factors and sample phase on site frequencies for quadrat samples 1 and 2.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.054	4	.013	.858	.491	
Domstr	.013	1	.031	2.019	.158	.13
Numstr	.010	2	.005	.309	.735	.07
Sample	.008	1	.008	.521	.472	.07
2-Way Interactions	.035	5	.007	.457	.807	
Domstr Numstr	.018	2	.009	.587	.558	
Domstr Sample	.000	1	.000	.005	.945	
Numstr Sample	.014	2	.007	.444	.642	
3-Way Interactions	.003	2	.002	.107	.898	
Explained	.092	11	.008	.539	.873	
Residual	1.870	121	.015			
Total	1.961	132	.015			

Multiple R = .1642
Multiple R^2 = .026

1 and 2. However, the mean number of sites for the Lawton dominated quadrats dramatically increases in quadrat sample 2, with only three such units included in the sample.

A two-way analysis of variance was performed, based on the restratification of quadrat sample 2 on the basis of soil variables. (Limestone Cobbly and Windthorst-Konawa soils as soil dominants were excluded owing to the low occurrence of these soils as quadrat dominants over the reservation. These soils are excluded as well in all subsequent analyses involving dominant soil as a variable.) These results show no significant differences for main effects or interaction effects while 38.7% of the variance of site density was explained (Table 7-14). There are then inconsistencies between analyses of quadrat sample 1 and 2 based on soil stratifications.

Table 7-14. Two-way analysis of variance of soil factors on site frequencies in quadrat sample 2.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.213	8	.027	1.383	.224	
Soil Dominant	.201	7	.029	1.492	.188	.38
Soil Complexity	.014	1	.014	.706	.404	.10
2-Way Interactions	.112	7	.016	.831	.566	
Explained	.325	15	.022	1.126	.356	
Residual	1.097	57	.019			
Total	1.422	72	.020			

Multiple R = .387
Multiple R^2 = .149

Table 7-15. Three-way analysis of soil factors and sample phase on site frequencies for quadrat samples 1 and 2.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.335	9	.037	1.980	.046	
Soil Dominant	.329	7	.047	2.494	.019	.32
Soil Complexity	.037	1	.037	1.956	.164	.11
Sample	.000	1	.000	.009	.924	.01
2-Way Interactions	.392	15	.026	1.388	.162	
Soil D Soil C	.239	7	.034	1.818	.089	
Soil D Sample	.088	7	.013	.666	.700	
Soil C Sample	.000	1	.000	.006	.938	
3-Way Interactions	.139	7	.020	1.055	.396	
Explained	.866	31	.028	1.485	.066	
Residual	2.484	132	.019			
Total	3.351	163				

Multiple R = .316
Multiple R^2 = .099

These differences, however, do not become apparent in the results of a three-way analysis of variance which includes both quadrat samples 1 and 2 (Table 7-15). Main effects of soil dominant are significant and interactions of soil dominant and soil complexity are significant. Sample effects are however, not significant, and this is related to the nonsignificant differences in interactions of soil dominant and soil complexity across both samples. The additive effects of these independent variables explain 31.6% of the variance of site density.

Analyses of Quadrat 1 and 2 Combined

Some comparative analyses have already been achieved between the first two quadrat analyses, both in terms of the results in conclusions for significance of effects, as well as in the consistency of such results between the two samples. This section will provide some summary analyses of both samples combined.

Table 7-16 presents breakdowns of means and standard deviations for site frequencies across three soil and hydrological variables for quadrat samples 1 and 2 combined. This table shows particularly high means for the following groups of types of quadrats, or variable interactions, which were also sampled to a reasonable degree.

1) Soil dominant 1, with soil complexity 1 and most all combinations of dominant stream rank.

2) Soil dominant 2, with soil complexity 1, dominant stream ranks 3-4; and soil complexity 2, dominant stream ranks 3-4 and greater than 5.

3) Soil dominant 8, with soil complexity 1 or 2, and dominant ranks 1-2.

These groups of quadrats and their higher mean site frequencies are again summarized by soil dominant and dominant stream rank in Table 7-17.

Table 7-18 presents the results of a two-way analysis of variance for the combined samples which shows significant main effects for soil dominant and significant interaction effects of soil dominant and soil complexity, and that the additive effects of these variables accounts for 31.6% of the variance of site density.

Table 7-16. Breakdown of site frequency by soil dominant,

Table 7-16. (Continued)

Soil Dominant	Soil Complexity	Dominant Stream	Site Frequency $\bar{x}$	sd	n
5. Limestone Cobbly	Simple	0	–	–	0
		1-2	0	0	1
		3-4	–	–	0
		5-	–	–	0
	Complex	0	–	–	0
		1-2	–	–	0
		3-4	–	–	0
		5-	–	–	0
6. Lucien	Simple	0	0	0	5
		1-2	–	–	0
		3-4	–	–	0
		5-	–	–	0
	Complex	0	–	–	0
		1-2	–	–	0
		3-4	.50	.71	2
		5-	–	–	0
7. Rocky-Stony	Simple	0	–	–	2
		1-2	.07	.26	14
		3-4	.25	.50	4
		5-	–	–	0
	Complex	0	0	0	1
		1-2	0	0	3
		3-4	0	0	1
		5-	–	–	0
8. Vernon	Simple	0	0	0	1
		1-2	.50	.56	6
		3-4	–	–	0
		5-	–	–	0
	Complex	0	–	–	0
		1-2	.60	.55	5
		3-4	0	0	1
		5-	–	–	0

Table 7-16. (Continued)

Soil Dominant	Soil Complexity	Dominant Stream	Site Frequency $\bar{x}$	sd	n
9. Windthorst-Konawa	Simple	0	–	–	0
		1-2	–	–	0
		3-4	–	–	0
		5-	–	–	0
	Complex	0	–	–	0
		1-2	0	0	1
		3-4	–	–	0
		5-	–	–	0
10. Zaneis	Simple	0	.50	.71	2
		1-2	0	0	4
		3-4	0	0	4
		5-	–	–	0
	Complex	0			
		1-2			

Table 7-18. Analysis of variance of soil dominant and soil complexity factors on site frequency for quadrat samples 1 and 2 combined.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.335	8	.042	2.284	.025	
Soil Dominant	.329	7	.047	2.564	.016	.32
Soil Complexity	.037	1	.037	1.998	.160	.11
2-Way Interactions	.301	7	.043	2.342	.027	
Explained	.636	15	.042	2.311	.006	
Residual	2.715	148	.018			
Total	3.351	163	.021			

Multiple R = .316
Multiple R^2 = .099

Table 7-19 presents the results of a two-way analysis of variance for the combined samples, which shows significant main effects for dominant stream rank, and that the additive effects of the hydrological variables accounts for 33.6% of the variance of site density.

Therefore, on the basis of the first two quadrat samples, certain levels of site occurrence may be suggested for certain environmental situations, which can primarily be recognized in certain levels of dominant soil type and dominant stream rank. In particular, soil dominants 1, 2, and 8 with respect to levels of 3, 2, and 1 dominant stream rank seem to have high mean site scores and such situations occur often enough to suggest further sampling and analyses of those would be important.

Quadrat Sample 3

As stated previously, the last quadrat sample was taken for two purposes, namely to test the predictive capabilities of the results of the previous sampling stages and to maximize the location of archaeological sites. Quite obviously, then, this last quadrat sample was designed to cover the areas with high site density. The first two

Table 7-19. Analysis of variance for dominant stream and number of stream factors on site frequency for quadrat samples 1 and 2 combined.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.347	4	.087	4.581	.002	
Domstr	.328	2	.164	8.667	.001	.32
Numstr	.012	2	.006	.315	.730	.06
2-Way Interactions	.048	4	.012	.629	.643	
Explained	.395	8	.049	2.605	.001	
Residual	2.766	146	.019			
Total	3.161	154	.021			

Multiple R = .331
Multiple R^2 = .109

quadrat samples have been shown to have revealed significant differences in the association of certain environmental variables with site frequency. The highest site densities were taken as the subject of this third sample. They include specific environmental settings as defined by edaphic and hydrographic variables. The settings sampled in this phase include: 1) Alluvial soil dominants with dominant stream rank greater or equal to five, 2) Granite Cobbly soil dominant with dominant stream rank equal to three or four, and 3) Vernon soil dominant with stream rank equal to one or two.

Table 7-20 presents breakdowns of means, standard deviations and variances of the types of quadrats or variable interactions sampled in this third quadrat sample. As can be seen, means for these three separate types of quadrats, representing distinct environmental situations, are all high, and in fact are very similar to the same measurement in Table 7-16 for the first two quadrat samples. Inspection of a further breakdown of quadrat sample 3 by soil complexity indicates consistently higher site densities for quadrats with complex soil associations (Table 7-21). To the degree that biotic factors are associated with these edaphic classifications then, it appears that the areas of high site density reflect further patterning of sites in areas of higher environmental diversity.

Table 7-20. Breakdown of site frequency by quadrat type in quadrat sample 3.

Quadrat Type	Number of Quadrats Surveyed	Site Frequency x	sd
Alluvial Soil Dominant, Stream Dominant Class 3	18	.78	1.00
Granite Cobbly Dominant, Stream Dominant Class 2	15	.73	.79
Vernon Soil Dominant, Stream Dominant Class 1	17	.47	.51

Table 7-21. Site frequency by soil dominant and soil complexity in quadrat sample 3. (n refers (to number of quadrats in sample.)

Soil and Stream Dominant Group	Soil Complexity	Site Frequency x	sd	n
Alluvial Soil Dominant Stream Group 3	Simple	.67	.98	12
	Complex	1.00	1.09	6
Granite Cobbly Soil Dominant Stream	Simple	.37	.51	8

Table 7-22. Analysis of variance for soil dominant factors on site frequency in quadrat sample 3.

Source	DF	Sum of Squares	Mean Squares	F ratio	F prob.
Between Groups	2	.0316	.0158	.420	.659
Within Groups	47	1.765[illegible]	.0376		

Table 7-23. Analysis of variance for soil dominant and quadrat sample stage factors on site frequencies for soil dominants sampled in quadrat sample 3.

Source of Variation	Sum of Squares	DF	Mean Square	F	Significance of F	Beta
Main Effects	.160	4	.040	1.085	.370	
Soil Dominant	.034	2	.017	.464	.630	.11
Sample	.140	2	.070	1.898	.157	.22
2-Way Interactions	.033	4	.008	.224	.924	
Explained	.193	8	.024	.655	.729	
Residual	2.833	77	.037			
Total	3.026	85	.036			

Multiple R = .230
Multiple R^2 = .052

On the basis of the first two quadrat samples, certain levels of site occurrence may be suggested for certain environmental situations which can primarily be recognized or described by certain levels of dominant soil type and dominant stream rank. In particular, soil dominants 1, 2, and 8 with respective levels of 3, 2, and 1 dominant stream rank tend to have high mean site scores. Quadrat sample 3, which sampled for these specific situations, upheld this conclusion.

Chapter 8

SITE DESCRIPTIONS

Introduction

The following discussions present information on the size, character and condition of the sites located on this reconnaissance. Those sites with numbers lower than Cm-162 had been located previously, mainly as part of the survey conducted by Schaeffer in 1959. Two sites, Cm-322 (the Parade Ground Site) and Cm-323 (The Crater Creek Burial Site) are discussed in seperate appendices. Tables presenting data on the assemblage composition, raw material usage and various attribute observations are presented in Appendix D. Notes on the typology, dealing with "diagnostic" artifacts are presented here when appropriate.

SITE 34-Cm-20

Cm-20 is a partially in situ site located on a low knoll overlooking a small lateral of East Cache Creek just at the edge of the latter stream's floodplain. Artifacts were found eroding from recent trails and vehicle ruts associated with an intensively used bivouac area and firing point. The main area of the knoll is covered with a dense growth of grasses but evidence of tracked vehicle ruts and turnarounds is abundant, suggesting that the whole knoll has been extensively disturbed in the past. The perimeter of the knoll is dotted with foxholes, many of which were still open at the time the site was located.

Surface collections were made by placing two circular collection areas each ten m in radius over the main artifact exposures. The few remaining artifacts were collected after mapping their positions.

A single test pit was excavated at the site in order to ascertain

[illegible] abundant lithic

SITE 34-Cm-38

Cm-38 is a moderately dense scatter of lithic artifacts exposed in a firebreak/road on a high bench on the north bank of Medicine Creek. Artifacts are exposed for approximately 50 m, along the firebreak/road and in one area where vehicle tracks lead down over the bench to Medicine Creek. In this latter area small amounts of faunal material were also found.

The road surface exposure was collected in three units each 20 m in length and the road's width wide (4-7 m). In addition to Shaeffer's (1959) collection of this site, Cm-38 has reportedly been collected by many visitors to the site (Morgan 1957:91). Morgan has also reported this site to be the location of an ethnohistorically described Comanche or Wichita occupation of the Punch Bowl area (1834-1842).

Cm-38 has been disturbed by heavy vehicle traffic along a dirt road and possibly by both the construction of Punch Bowl Road and foxholing. It is recommended that activity be suspended from this area until testing of the site can be accomplished in order to establish the

SITE 34-Cm-65

Cm-65 is a small, but moderately dense surface site on an alluvial bench west of Blue Beaver Creek. The creek supports a flood plain plant community interspersed with grass dominated clearings. These are both present on the site.

Cm-65 was collected in seven rectangular units (each 50 sq m in area) on a dirt road.

Both Blue Beaver Creek Road and the dirt track have disturbed the site as has a bulldozed area in the northern portion of the site. In situ deposits with archaeological features or artifacts may possibly occur at Cm-65, but testing would be necessary to document them. If the site is not further disturbed, more work (i.e., test excavations) should not be necessary, but if increased disturbance takes place testing should be conducted in order to allow fuller evaluation of the site.

SITE 34-Cm-67

Cm-67 is a fairly dense surface and possibly in situ site located on a broad low erosional bench of old colluvial material on the north bank of Blue Beaver Creek. Artifacts have been eroding from a slope on the creek bank edge of the bench along a 300 m length of a firebreak road. The bench's eroded slope edge is under a light cover (20%) of mid-grass. The major portion of the bench north of the eroded slope appears to be intact and is under a heavy cover of mid-grass (80%) except for a plowed wildlife planting strip in which no artifacts were observed.

Four 10 m^2 units were placed in the eroded portions of the bench in an area with the greatest concentration of exposed artifacts. The firebreak road was divided into two units. Two auger holes were placed in the alluvium on the north bank of the creek near the location of two deeply buried (120-130 cm) large fragments of unidentified bone exposed in the banks face. These tests indicated a fairly continuous loose sandy fill to at least 130 cm. However, at a depth of approximately 70 cm a tangle of communication wire was found, indicating heavy recent filling along the creek at this location, probably from sheet erosion of the bench containing the main artifact concentrations.

Undeterminable portions of Cm-67 have been destroyed with firebreak road construction, subsequent traffic and activities associated with F.P.'s 664, 665. These later activities are the cause of the considerable amount of erosion along the collected area of the bench's slope.

Testing of Cm-67 is recommended in order to determine the sites' states of preservation in remaining, apparently undisturbed

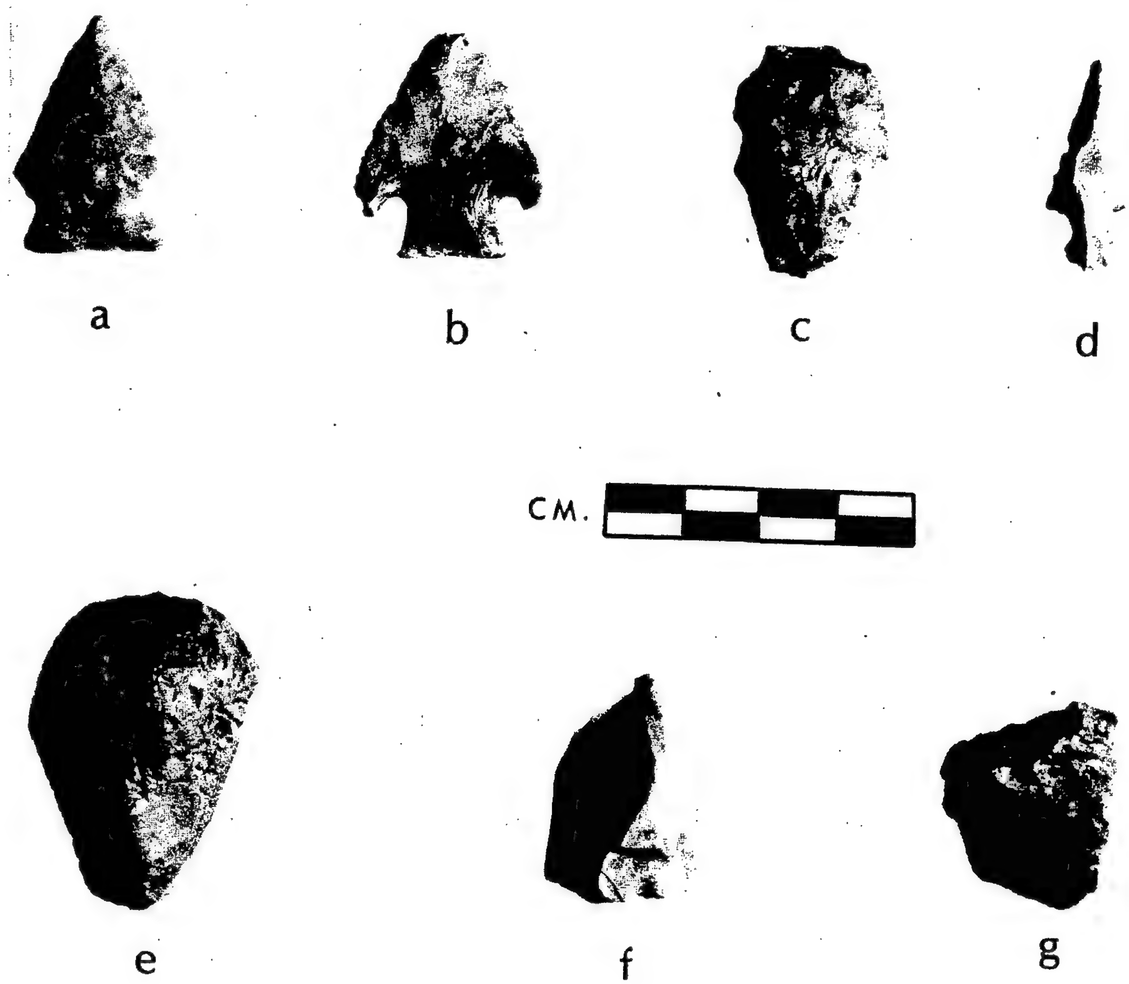


Figure 8-1. Artifacts from site Cm-67. a-d-Projectile points; e, g - endscrapers; f - sidescraper

areas (north) from the eroded slope area. Until testing is completed, firing activity should be suspended from the locale and traffic limited to the firebreak-road. Additionally, plowing of the wild life plot should be suspended until tests of the soil immediately below the present plow zone can be accomplished.

Notes on the typology: The assemblage from this site is dominated by retouched pieces which may reflect nothing more than the traffic the site has received (this was considered during classification and conservative judgements were exercised). The projectile points include mostly larger forms with contracting stemmed (Figure 8-1: c) and expanding stemmed forms present (Figure 8-1: a,b). One unifacial point is quite atypical, but resembles Bonham or possible Alba forms (Figure 8-1: d). Two endscrapers (Figure 8-1: e,g) and one side-scraper are present (Figure 8-1: f).

SITE 34-Cm-68

Cm-68 is a surface and possibly *in situ* lithic artifact scatter (150 sq m) located on an alluvial terrace on the north bank of Blue

the site is covered by a stand of oak trees, while the remainder is covered either by completely bare ground or by the edge of the dense grassland which flanks the site to the east and north. Two firing points are located on the fringes of the site and the area under the trees appears to be used for a vehicle park. A deeply eroded trail runs along the trees toward one of the firing points. The periphery of the site is scarred by numerous ruts and vehicle turnarounds.

The densest artifact exposures were found in the deeply eroded trail. Less frequent artifacts are present on the surface under the treed area as well as in the vehicle tracks, turnarounds and areas of erosion. *In situ* material is probably present under the trees and in the grassy areas on the north and eastern portions of the site. Much of the material under the surface may have been disturbed some time

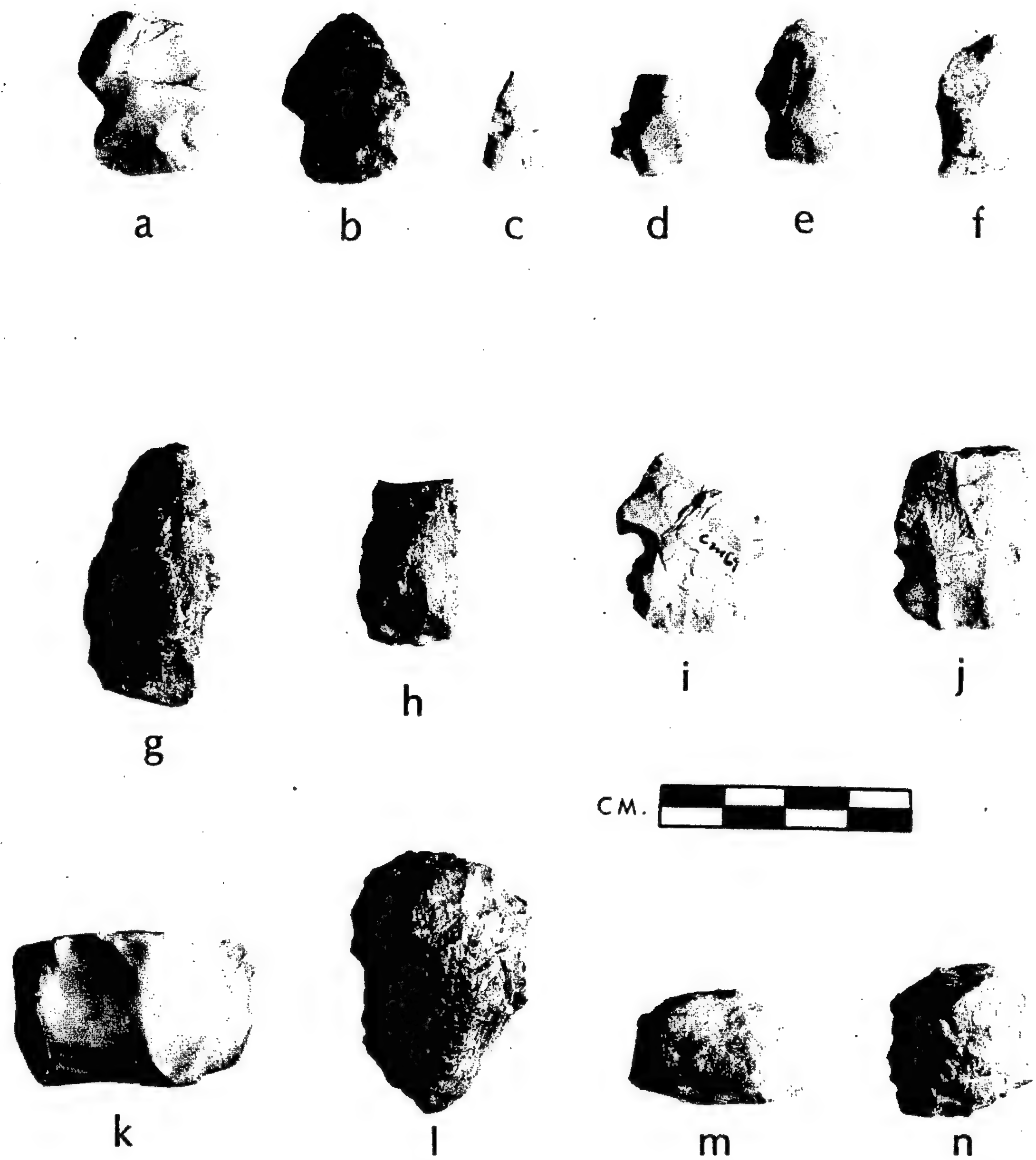


Figure 8-2. Artifacts from site Cm-69. a-f, i, j - projectile points; g, h - preforms; k - core; 1 - n - endscrapers.

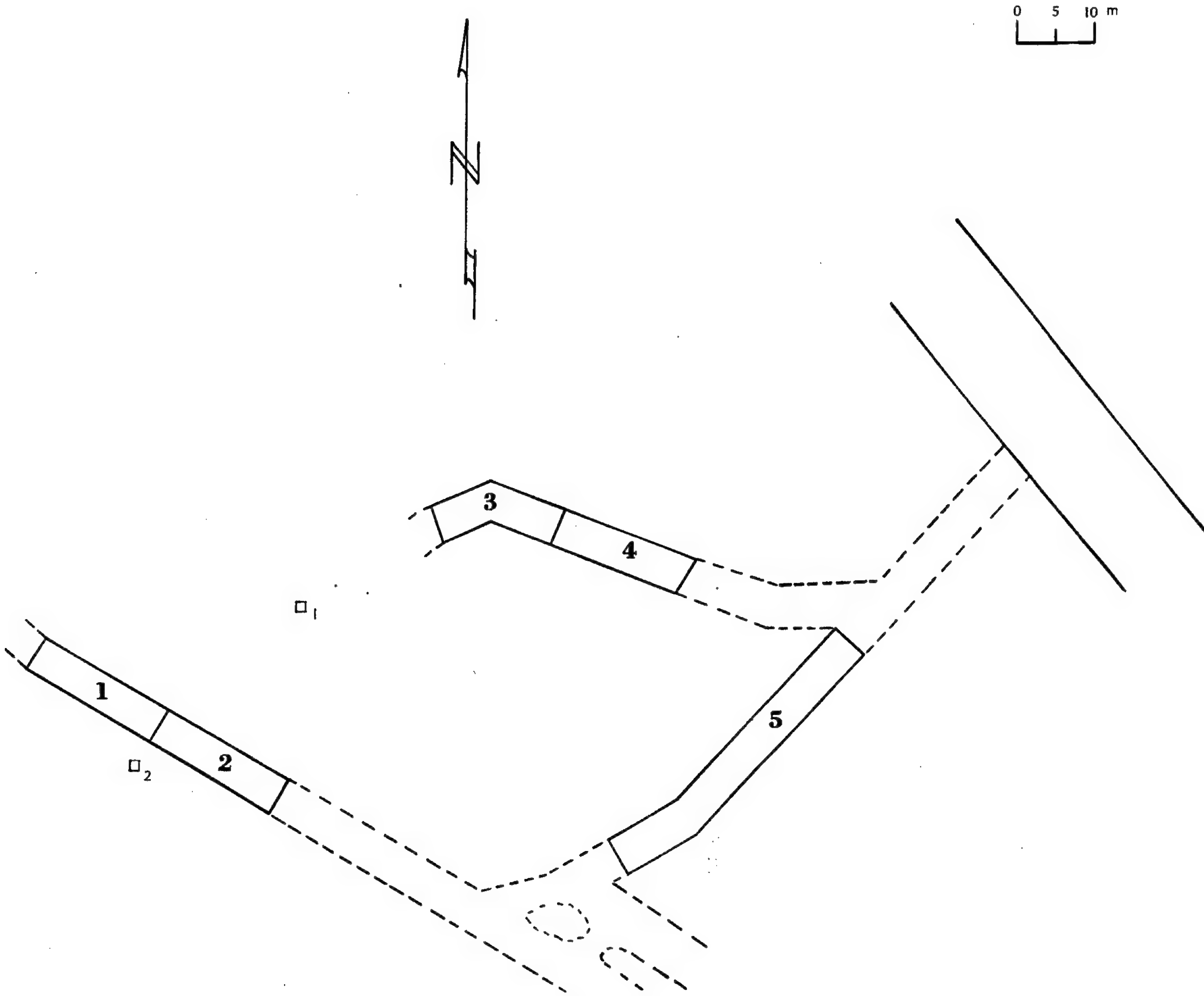


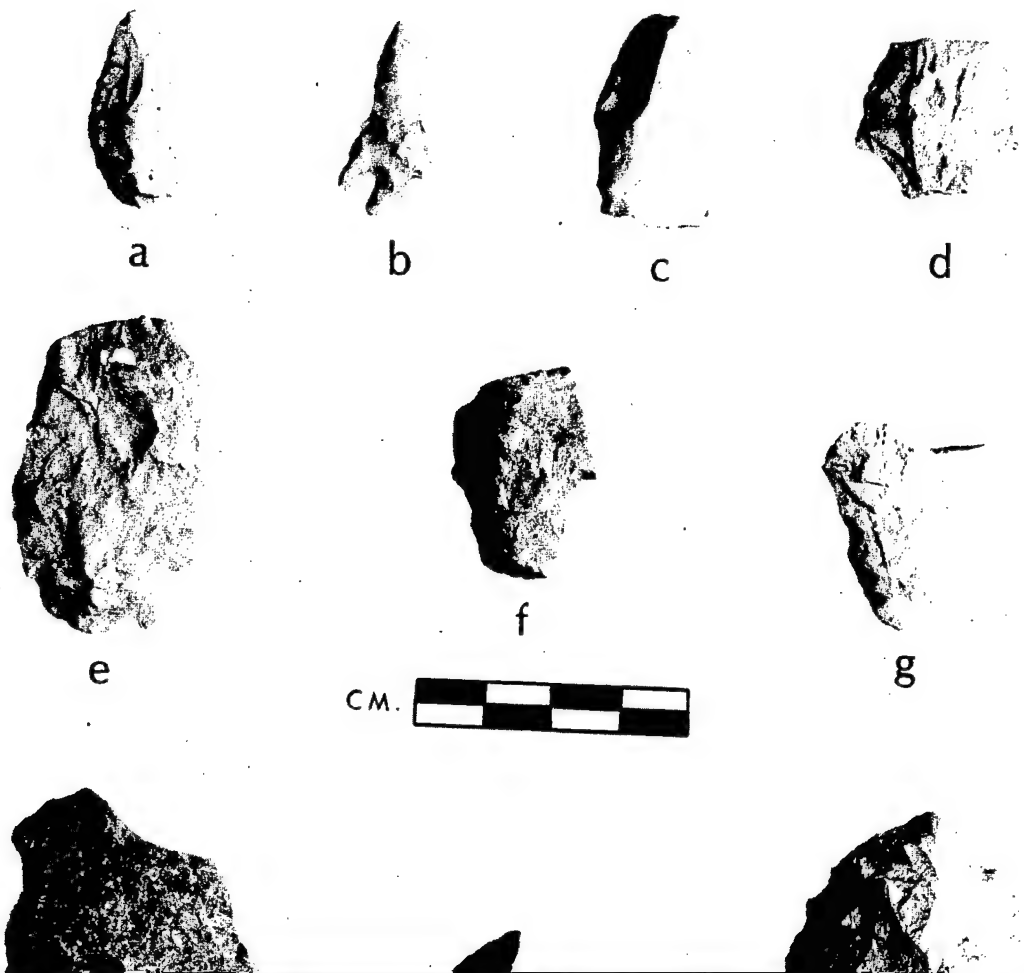
Figure 8-3. Map of Site 34 - Cm 71 showing areas of surface collection and location of test pits.

Creek adjacent to a second-order stream. The site area is under a light to moderate understory of mid-grass, and a moderately heavy overstory of Post Oak and Blackjack Oak.

Cm-71 was collected in four units 18 m long, which were imposed on eroded road areas 7 - 10 m wide running through the site in several areas. Later these units were recollected after heavy rains (Figure 8-3).

Two test pits were excavated at the site in order to document the presence of suspected in situ deposits (Figure 8-3). One pit was placed just west of the deeply eroded portion of the road which transects the western portion of the site. This pit yielded quite artifactual material to a depth of approximately 20 cm in the colluvial deposits there. Another test pit, farther downslope and more toward the center of the site yielded in situ material to a depth of about 35 cm.

Cm-71 has been badly damaged in some areas through vehicle traffic associated with the area's apparent use as a bivouac area. In situ material exists in the site area, especially south of the most heavily disturbed areas near test pit two. Two major alternatives may be recommended for Cm-71. First, activity could be suspended from


a
b
c
d
e
f
g
CM.

of the clearing where road cuts have caused erosion. Vegetation on the site consists of a moderate (50%) cover of mid-grass and an overstory of Post Oak and Blackjack Oak.

Cm-72 was collected in 5 point-radii units 5 m in radius placed over visible artifact concentrations.

The eastern portion of this site has been almost totally

Notes on the typology: The four projectile points at this site offer the most variability encountered in any assemblage at Fort Sill. Two appear to be late prehistoric, one apparently a Fresno type (Figure 8-5: a) and the other a Washita (Figure 8-5: b). The third is a basal fragment of a larger dart point, possibly similar to an Ellis type (Figure 8-5: c). The fourth is the base of what appears to be a Plainview point (Figure 8-5: d). Both sides of the remaining basal section have been finely ground. If these point identifications may be relied upon to any degree, then this site seems to have evidence of occupations spanning the Paleo-Indian to Plains Village periods. That either or both of the earlier points was picked up by later inhabitants is of course possible, yet the "Plainview" fragment is the single piece of evidence which may bear on the Paleo-Indian period which may be reported here from this reconnaissance.

SITE 34-Cm-74

Cm-74 is a sparse but extensive artifact scatter located on a broad, low bench of colluvial material and developed prairie soils on the east bank of Blue Beaver Creek. This ridge is under a heavy cover of mid and tall grasses (80%) except where vehicle disturbances of the slope have created slight amounts of erosion. Artifacts are exposed in the latter areas for a distance of approximately 500 m along the bench.

Five exposures with light concentrations of artifacts were collected with 10 m point-radii units. Single artifacts occurring outside these units were also mapped and collected.

The major portion of the ridge where Cm-74 is located appears undisturbed. However, some vehicle tracks and turnaround ruts, as well as some fox holes are present. These disturbances are probably associated with firing points 624 and 649, located on the flood plain of the Creek just to the west of the site. No future work is recommended for the site.

Notes on the typology: The single projectile point from the site is a medium sized, expanding stemmed piece, suggesting an Archaic or Woodland age for the site.

SITE 34-Cm-92

Cm-92 consists of a light, but extensive lithic artifact surface scatter located on an eastern slope of a ridge above Post Oak Creek, which was observed along 100 m length of firebreak road approximately 8 m wide.

Just previous to the collection of the site the firebreak was plowed, which effectively buried most of the artifacts observed on the surface. as a result, a total collection of visible artifacts was made without superimposing grid units.

Cm-92 will be continually damaged through firebreak maintenance as well as resulting erosion. Since in situ material may well occur on both sides of the firebreak, testing of those areas should be undertaken should the location of the firebreak be changed.

SITE 34-Cm-93

Cm-93 is an extensive artifact scatter (4,500 sq m) located on a ridge of colluvial material approximately 60 m east of Post Oak Creek.

Artifacts were observed both in a north-south firebreak-road and in an area between this road and the creek. Vegetation off the road consists of a heavy (85%) cover of mid-grass.

Prior to the collection of this site the firebreak-road was plowed, burying all but a few artifacts, and thus the remaining observable artifacts were collected without superimposing grid units. Previously, two concentrations of artifacts had been flagged for collection within the road, but these were obscured by the firebreak maintenance. .

Cm-93 will be continually disturbed by firebreak maintenance; the portions of the site now in the firebreak appear to be disturbed to the point that horizontal and stratigraphic artifact proveniences have been destroyed. Strict maintenance of the firebreak position will protect the adjoining areas of the site from further damage

[redacted] This site is the traditional location of the dune used by Ceres

SITE 34-Cm-234

Cm-234 is a moderately dense and moderately extensive artifact scatter (6,000 sq m) located on a knoll-like remnant of the Post Oak Formation, on the west bank of Blue Beaver Creek immediately south of McKenzie Hill Road. Artifacts were observed over heavily eroded portions of the knoll top and primarily over the eastern slope of the knoll which is also heavily eroded (Figure 12-5, a). These eroded areas were under only a light cover of mid-grass (10%) or were totally bare, but a heavy cover of grasses and forbs is present where slopes are more gentle.

Cm-234 was partially collected in 15, 10 m x 10 m contiguous quadrats which were laid out over knoll's top on an area of heavy erosion with a relatively high density of artifacts.

Cm-234 has been heavily eroded, undoubtedly due to vehicle activity resulting from use as a firing point. The eastern slope of this knoll and site has particularly been disturbed by both vehicle traffic and bulldozing. The recovery of a large controlled sample from this site, and the probable lack of in situ material leads to no recommendations for further work at this site.

SITE 34-Cm-235

Cm-235 is a fairly light artifact scatter observed along a 320 m length of dirt road, on a high terrace of the north bank of Medicine Creek immediately west of the Chrystie Hill. Artifacts were only observed in the road, but soils are apparently undisturbed and under a heavy (70-80%) cover of mid-grass to each side of the road.

Cm-235 was collected with 30 linearly arranged units each 15m in length and the road's width wide (approximately 2.5 m).

on the west bank of Blue Beaver Creek just south of McKenzie Hill Road, near a confluence with a second order stream, and below a ridge of low hills. The site area is under a heavy cover of mid and tall-grass except on a dirt road area and on some vehicle turnarounds. Lithic artifacts which were observed in a road cut at the edge of the terrace and in the back dirt of a fox hole were collected as one unit.

The area in which Cm-236 is located has been heavily disturbed by vehicle traffic, and by both fox holes and trash pits dug in the area.

Testing may be warranted at this site to confirm the presence and [illegible]

SITE 34-Cm-239

This is an exceptionally large site, located along a high old terrace or bench overlooking Medicine Creek. Lithic artifacts were located in a dirt road and in disturbed areas along the road for a distance of approximately 400 m. The size of the site can only be estimated, since exposures away from the road are limited by dense growths of grasses and brush.

Seventy-six collection units were defined by the width of the road and 5 m lengths. One additional surface collection area was defined on the basis of a narrow eroded area just west of the road. These surface collections yielded about 1200 artifacts which were sampled for detailed analysis. The denser concentrations of artifacts appear to be both a product of erosion (since the road is much more eroded in these areas) and also true artifact concentrations. Two test pits were excavated in the vicinity of the major artifact concentrations. Both of these pits demonstrated the presence of substantial in situ deposits of artifacts.

The results of both testing and surface collection indicate that site Cm-239 is a large, probably multi-occupation, prehistoric and/or very early historic site. Substantial portions of the site appear to have been heavily disturbed by road erosion, vehicle traffic off the road and other activities such as foxhole excavation. This site has great potential for the study of the various occupations represented and is thus a site which should be carefully preserved. While additional testing would be necessary to fully define the horizontal and stratigraphic limits of the site, the areas defined thus far should be protected from further damage. It is recommended that traffic in the area be restricted to the present road and that other ground disturbing activities be curtailed. If these actions are not feasible, a testing program should be launched which will more fully define the spatial and cultural parameters of the site so that mitigative efforts can be better evaluated and/or formulated.

Notes on the typology: The large sample of artifacts produced almost no diagnostic artifacts. Two simple endscrapers were present in the sample which was coded, while the only distinctive tool in the remainder of the assemblage is a broken bifacial drill made of Alibates flint.

SITE 34-Cm-240

Cm-240 is an in situ occupation site located on an old terrace of Post Oak Creek. The site is situated on the low terrace which is separated from the modern channel by an abandoned channel and several terrace features. It is thus on the opposite side of the fossil channel

from site Cm-241 and about 100 m upstream. Cm-240 was located because of surface exposures of artifacts in patches of minor erosion. The location of these eroded areas containing artifacts suggested the possible presence of in situ material, and testing was initiated.

Two, 1 sq m test pits were placed along the crest of the old terrace (Figure 8-6, a). Each test pit was excavated to a depth of 45 cm, and all of the excavated matrix was screened through 1 mm mesh. Both pits yielded substantial quantities of lithic artifacts and small amounts of poorly preserved faunal material down through the lowest excavated levels. The full depth of these cultural deposits is thus not known.

This site has excellent potential to contribute to the chronometric, stratigraphic and cultural history of the area. Its presently undisturbed condition should be maintained through restriction of all activities from the site area. Should any activities threaten the site, the upper levels merit fuller excavation and the lower limits of the deposits should be defined in order to assess the full scope of necessary mitigative efforts.

a

b

Figure 8-6. Photographs of Sites Cm-240 and Cm - 241. a - Site Cm-240; b - Site Cm - 241

Notes on the typology: The mid-section of a large projectile point of Ogallala, and a large preform suggest an Archaic age for the site, but the tool sample is too small to permit firmer observations.

SITE 34-Cm-241

Cm-241 is a small (200 sq m) surface and in situ site located on a low eroded terrace feature on the west bank of Post Oak Creek near the northern boundary of Fort Sill. Artifacts were observed on the western eroded edge of the low rise where a heavy (80%) cover of mid-grasses thins considerably (Figure 8-6,b). The site area is also under a moderate overstory of Post Oak and Blackjack Oak.

Cm-241 was totally collected with a contiguous system of seven, 5 m^2 grid units. One, 1 m^2 test pit was also placed on the site. It yielded bone fragments and small flakes in the first 5 cm level of gravely topsoil. In level 2 a sterile stratum of larger gravels was encountered.

Little or no military activity occurs on Cm-241 but erosion is cutting into its western slope. At least some form of erosion control should be implemented at the site and more testing may be warranted if Site Cm-240 is further tested in order to establish possible rela-

SITE 34-Cm-243

Cm-243 is an extensive and in places dense surface scatter of turn-of-the-century to World War I debris. It extends for 700 to 800 m parallel to Medicine Creek in a band of approximately 100 m width on the south side of the Creek and immediately west of Four Mile Crossing. The site has been damaged not only by downslope wash aggravated by continual burning off of vegetation in the area, but also by vehicle traffic and by artillery shell impacts. Large numbers of spent cartridges and bullets indicate also some past use for target practice.

Evidence of possible habitations is also present. Badly decayed wood in the midst of artifact clusters imply possible use for structures although the amount of structural debris belies the presence of large buildings. While this occupation may represent, for example, a part of a temporary training encampment, it is also close to if not at the reported location of the village of Chatto, who as an Apache prisoner-of-war lived in the area in the 1890's (see map in Debo, 1976:368-369). While the Apache prisoner-of-war structures were not large, they were elaborate enough to have left significant archaeological remains possibly not visible on the ground surface.

Although the area is within the margins of the West Range and subsequently "off limits" to traffic, some traffic does pass through the northern edge of the site as indicated by the presence of a dirt road there paralleling the Creek. It is therefore recommended that traffic along that road be stopped if possible and severely limited if not. Depth of the site may be slight or non-existent. A review of pertinent documentary evidence in conjunction with limited testing should be made to confirm the location of the Chatto village. Should this site be discovered to be the Apache village, the site would be subject to those recommendations made concerning all Apache POW villages (see Chapter 14). Should it be found that this site is not that of Chatto's village, an assessment of significance should be made on its own merits. If significant, at least a controlled surface collection should be made to mitigate the effects of the adverse impacts presently affecting the site.

SITE 34-Cm-244

Cm-244 is a small surface scatter of historic debris located 100 m to the south of Cm-245 on a granite cobbley ridge extension overlooking the west bank of Post Oak Creek. The exposure is in a small draw on the edge of a clearing surmounting the ridge.

A complete collection was made of the small deposit which included metal, ceramic, and glass artifacts. Portions of at least four and

possibly five glass bottles can be distinguished, along with one purpled fragment of a glass lamp chimney. Ceramic artifacts include two sherds from a 4-gallon crock and several sherds of an ironstone plate with some overglaze painting or perhaps decalomania. The rest of the artifacts are iron and include a crimped seam bucket, hole-in-the-top tin can fragments, a square cut nail, a lap welded piece of strap stock, and two probable farming implements.

The collection shows no evidence of military associations and is therefore likely civilian. Although this would be expected with a refuse collection, no evidence was found for a nearby habitation. It could possibly have been deposited by travelers or by those in a temporary camp on a new allotment. Based on the presence of purpled glass, hole-in-the-top tin can fragments, etc. dating of the collection would be turn-of-the-century to early 20th century.

SITE 34-Cm-245

Cm-245 is a light limited scatter (250 sq m) of historic debris located on a granite cobbley ridge extension on the west bank of Post Oak Creek. Artifacts including crockery, bottle fragments and miscellaneous metal scraps were observed in an erosion feature on the top west side of the ridge extension. A moderate understory cover of mid-grass (50%) and an overstory of Post Oak and Blackjack Oak exists on the site area.

No artifact collections were made. No evidence of a structure(s) could be found and it is assumed this represents an early 20th century dump. No disturbance on the site area can be attributed to military activity. No further work on the site is recommended because of the extreme displacement of artifacts.

SITE 34-a-246

Cm-246 is an extensive (16,000 sq m) lithic artifact scatter with three major concentrations, located along the west bank of West Cache Creek, on a gentle knoll of colluvial material. On the southern portion of the site a moderate to heavy (50-70%) cover of mid-grass exists. On the central and northern portion of the site the cover of the mid-grass is light (20-30%). The knoll area in general is also covered with a light overstory of Post Oak and Blackjack Oak.

Cm-246 was collected with nine, 10 m x 10 m units. One of these units was located on the heavily eroded area near the bank in the southern

portion while six units were collected on the central knoll, and two
units were collected on a slope on the northern portion of the site.

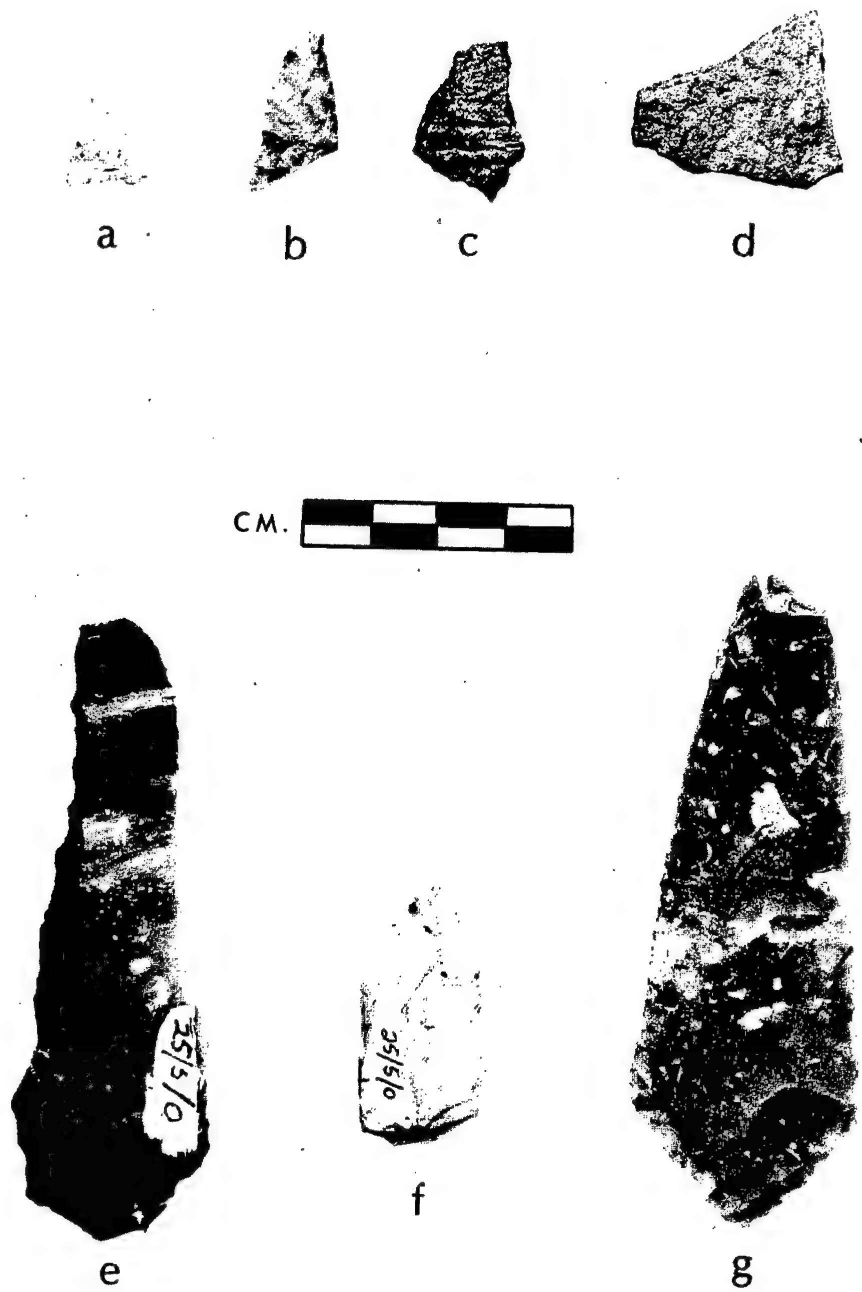


Figure 8-7. Artifacts from sites Cm-246 and Cm-303. a-b, projectile points; c - cordmarked sherd; d - plain sherd; e - alternate edged knife; f - broken biface with burin spalls; g - bevelled knife on bifacial blank. (a-f from Cm-246, g from Cm-303).

The ridge is under a moderate (50%) cover of mid-grasses and artifacts are exposed on a soil largely composed of angular fragments and cobble stones of limestone.

Due to the sparsity of materials at Cm-248 an intensive collection of observable artifacts was made without super-imposing grid units.

The ridge extension on which Cm-248 is located has been disturbed by activities of an unknown nature which have created some amount of erosion. Due to this disturbance, the sparsity of surface material, and an apparently shallow soil, no testing is recommended for Cm-248.

SITE 34-Cm-249

Cm-249 is a very large <u>in situ</u> occupation site located on a high bluff overlooking the East Cache Creek floodplain. The total site size cannot be estimated owing to heavy vegetative cover in some areas but it is in excess of 20,000 sq m. Artifacts and some faunal material are exposed in areas of erosion and disturbance. Dense growths of grasses and forbs have, at least in the recent past, stabilized the shallow soil cover and concealed artifacts. A number of trails which are currently being used as a driving instruction area pass through or near the site. These trails receive a heavy amount of traffic and are deeply eroded for the most part. Few artifacts are present in these trails but exposures of up to at least a meter of Permian deposits in them suggest that any artifact-bearing sediments have been completely eroded away.

Four areas of dense artifact exposures were surface collected by the use of circular collection units ten m in radius (Figure 8-8). Two test pits were excavated at the site to investigate the presence of suspected <u>in situ</u> deposits. Square one, excavated to a depth of 20 cm, indicated the presence of a shallow but apparently undisturbed deposit of abundant lithic artifacts. Square two revealed the presence of lithic artifacts as well as faunal material to a depth of at least 25 cm.

This site thus appears to be an important, large late prehistoric or possibly proto historic site with quite extensive <u>in situ</u> deposits rich in data relating to the activities and cultural affiliations of its inhabitants. Such sites are rare in this region and are even more rare in the Fort Sill area. It is strongly recommended that the site be preserved and protected from further disturbance. The latter will entail some means of erosion control as well as traffic control. Further testing will be necessary to define the full extent of the <u>in situ</u> deposits or to evaluate the site for further research should site stabilization be unfeasible.

Notes on the typology: Two projectile points were found suggesting a late prehistoric age for the site. The first is a small expanding

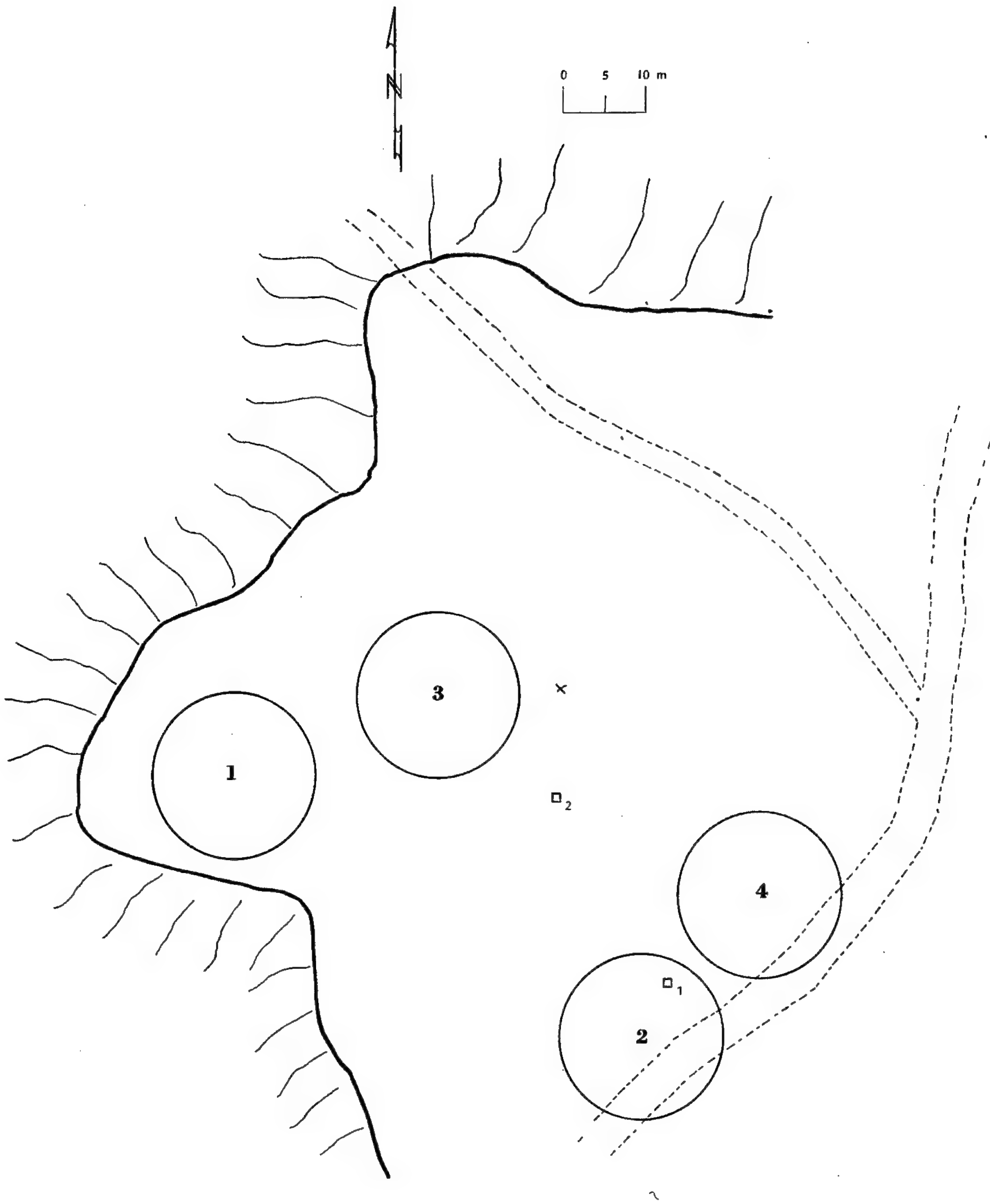


Figure 8-8. Map of Site 34-Cm-249, showing approximate extent of the site, locations of surface collection areas and test pits.

stemmed point similar to the Bonham type. The neck width is 4.3 mm. The other is a mid-section of a small triangular or perhaps side-notched point. The blanks and preforms from the site also suggest that small, late varieties of points were being produced at the site. The scrapers include one large endscraper and one large broken side-scraper.

SITE 34-Cm-250

Cm-250 is a small artifact scatter (100 sq m) located on the top of a broad, low ridge between two first-order laterals of the East Branch of Wolf Creek. Artifacts were concentrated in one approximately 14 sq m area, where a generally moderate (60%) vegetation cover had been removed by vehicle traffic.

Artifacts were collected from the concentration area in one point radii area, 3.5 m in radius, which was divided into quarters for collection units.

Cm-250 has been damaged by vehicle traffic, and is located within an area which will probably be disturbed with construction of new Ammo Depot Igloo's. The shallow, and quite possibly disturbed soil mantle at the site makes the likelihood of in situ material quite low. Protection of relatively similar sites south of this one seems a more viable alternative to additional work at this site.

SITE 34-Cm-275

Cm-275 consists of lithic artifacts and bone eroding out of the face of the west bank of West Cache Creek. These artifacts occur in a deposit of alluvial soil 43cm-62cm below the surface and 49 cm above the Post Oak conglomerate, which is the bedrock of the area. Artifacts occur for approximately 17 m along the creek bank. Above the steeply cut bank, a moderate (50%) cover of mid-grass exists. Three observed lithic artifacts were collected and the bone left in place.

Cm-275 has not been disturbed by military activity but is being eroded away naturally at an unknown rate. Geomorphological studies in the site vicinity suggest that the artifacts are probably not in primary context, but that they are included in disturbed colluvium which has been eroding from a higher, older terrace of the stream. In situ materials could be present above the materials currently exposed. These areas above the site should be tested should extensive disturbance in the area be planned.

Notes on the typology: Only three artifacts were recovered from this site. One is an unretouched rhyolite flake and the other two are projectile points. One projectile point is a very small distal fragment

about 1.6 mm thick. The other is a small apparently stemmed but possible side notched point which is broken at the thin neck. These both appear to be late prehistoric points.

SITE 34-Cm-276

Cm-276 is a small (180 sq m) artifact scatter located on the edge of a bluff, a remnant of the Post Oak formation, which forms the west bank of West Cache Creek. The site area is under a light (30%) cover of mid-grass and a patchy overstory of Blackjack Oak and Red Cedar.

Observable artifacts were collected in total, as a single unit, due to low artifact density. No in situ material appears to be present owing to the shallow soil mantle. Cm-276 is located near a former firing point which apparently has not been used for some time, and the extent of damages which might have occurred to the site cannot be evaluated. No testing or further work is recommended for Cm-276.

SITE 34-Cm-277

Cm-277 is a moderate-sized light scatter of lithic artifacts located on the edge of a bluff of sandstone and conglomerate on

top soil. Ground cover above the site was too heavy to permit surface examination. No artifact collection was made.

A nearby historic marker identifies the area to be the location of Camp Comanche, occupied for a short time in 1834 by the Dodge Expedition. To the south of this marker is an area used for instruction in bulldozer operation, which has been obviously disturbed. The exposed material in the bank, however, appears to be in situ.

Initial observations of the material lead to conclusions that at least the material from the exposure is too late and too dense to have been deposited by Dodge's expedition. Instead, the material may have been deposited at the location of the artisan's encampment mentioned by Nye:

> These artisans, mostly key men, such as foremen, stonemasons, carpenters, and plasterers, were quartered with the teamsters in a canvas camp located near the site of Hoyle Bridge (Nye, 1969: 102),

or some other later historic occupation. The possibility also exists that this is an as yet undisturbed portion of the original Post dumping ground.

Testing of this site is recommended 1) to obtain a date for the site, 2) to learn something more of the occupation itself, 3) to establish more clearly the areal extent of the site, and 4) to determine whether or not this site warrants nomination to the National Register.

It is important that testing and an accurate assessment of this site be made quickly. Channel straightening of East Cache Creek by the Post Engineers in recent years has destroyed portions of the site and has created rapid stream flow which is undercutting the Creek bank and threatening to destroy much of the remaining site. Should the intact nature and historical significance of this site be proven by testing, full mitigation of those portions of the site threatened by these destructive influences is recommended.

SITE 34-Cm-279

Cm-279 consists of a complex of historic debris and fences probably related to an as yet unlocated habitation site. Two areas exist approximately 300 m apart and separated by a small stream channel which issues from the southern flank of an unnamed prominence near Koehler Hill. No collection was made from the site.

The artifact scatter lies at the base of the hill in tall grass. It contains unidentified pieces of iron as well as numerous pieces of bottle glass of varied types. Most appeared to have been broken in place. Most were found slightly up the rocky slope where the vegetation was thinner. This glass ranged in age from turn-of-the-century to modern.

The walls were of dry-stacked stone native cobbles and were located some 300 m to the west of the artifact scatter and somewhat upslope where the vegetation is much thinner. Here two short lengths of wall were aligned at right angles to each other and oriented in the cardinal directions. Nearby also were weathered fence posts held up by stacked stone piles. Both probably represent fence lines. In the area of these fences was a thin scatter of artifacts including a piece of pressed purple glass and a .38-40 centerfire cartridge of civilian manufacture.

The only disturbance impinging on the site is a hunters road and resulting erosion which approaches but does not reach to the portion of the site consisting of an artifact scatter. The site indicates an occupation dating perhaps from the turn-of-the-century to the present. It is recommended that, if possible traffic in the area be kept to a minimum and that documentary evidence of occupations in that area be checked so as to establish possible relationships. Should significance be found for the site and damage be impending, mitigation is recommended.

This system of fencing by rock pile and post or by dry-stacked cobble wall represent an adaptation unique in this area to the Wichitas and specifically aimed at providing pasturage on slopes which hold too little soil for the implantation of a standard post in post hole. This site represents one of many examples visible in the Wichita Mountains of the ingenuity of the pioneers of this area. Most of these are in areas which attract little use at present. However, those which lie at lower elevations and those which might be threatened in the future represent a valuable historical resource. It is recommended that attention be paid to the condition of these walls in future considerations of cultural resources and that where threatened, the presence of these be documented by ground survey, accurate mapping, and record research where possible.

SITE 34-Cm-280

Site Cm-280 is an extensive surface site marked by the occurrence of abundant lithic artifacts in a road which extends down the center of a long, gently sloping ridge which overlooks the western portion of the East Cache Creek flood plain. The terrain around the site is marked by gently rolling, dissected hills covered with almost pure stands of mixed grasses. Much of this grassland is under hay lease, and the portions of the site not exposed in the road were covered with dense, freshly-mowed grass at the time the site was discovered.

Lithic artifacts were visible for a distance of about 130 m along the dirt road. Excessive ground cover on either side of the road prohibited accurate site size estimation. The site was surface collected, using thirteen units, each 10 m long and the width of the road (approximately 2.5 m). Shallow soil deposits on either side of the road may contain artifacts in primary horizontal position, but testing of these areas should not be necessary unless major disturbance to the area is projected.

SITE 34-Cm-281

Cm-281 consists of a moderately extensive (2,500 sq m) but light artifact scatter located on a high colluvial ridge on the west bank of Blue Beaver Creek. The vegetation cover on the site area was light to moderate (20-40%) cover of mid-grass. Post Oak and Blackjack Oak were present at the fringe of the site and bench above the creek's flood plain.

Artifacts were collected from two exposures, and due to the low density of material no grid units were super-imposed over the area. Cm-281 has been damaged by vehicle traffic with subsequent erosion and/or deflation. There is little or no chance of in situ material remaining on this site, and therefore no further work is recommended.

SITE 34-Cm-282

Cm-282 is a light, extensive artifact scatter (5,000 sq m) located around the upper drainage area of a small first-order stream on the east slope of a broad ridge area to the northeast of Snow Ridge. Artifacts were exposed in small areas of sheet erosion. The vegetation of this area consists of a heavy (90%) cover of grasses which at the time the site was discovered had been recently mowed.

The site was collected in two units which roughly halved the area. No further work is recommended for the site owing to the sparsity of materials and a lack of potential in situ deposits.

SITE 34-Cm-283

Cm-283 consists of an extensive artifact scatter (4,800 sq m) located on a colluvial ridge adjacent to the western flood plain of Blue Beaver Creek. The site area is covered by a light to moderate cover of mid-grasses and a few Post Oak and Blackjack Oak.

The site was totally collected in two units, which were divided by a road running east-west through the site area.

Cm-283 has been disturbed by both natural erosion and by vehicle traffic on the road which runs through the site, associated with a firing point directly south of the site. Overall, there seems to be little possibility of <u>in situ</u> material on this site and no testing is recommended.

Notes on the typology: A single broken projectile point was recovered. It is medium-sized and has side tangs and an expanding stem.

SITE 34-Cm-284

Cm-284 consists of a scatter of historic debris on a ridge overlooking the East Branch of Wolf Creek just 100 m south of McKenzie Hill Road where it intersects Tower Two Road. Although the area is grassed, in places thickly, disturbance to the site makes ground exposure good. The site area is roughly circular, about 75 m in diameter.

Most of the site is probably gone as a large borrow pit cuts it in half. Although a surface site with little apparent depth, horizontal distribution of the remaining portions of the site is being further altered by erosion along the pit edges. Artifacts occur on both the east and west edges of the ca. 40-meter wide pit although the concentration along the east edge is much more dense. No artifact collection was made.

The artifacts themselves consist of crockery, broken bottle and window glass, semi-vitrified pottery, and fragments of iron. The pressed purple glass and semi-vitrified ceramics with machine-made bottles imply an early twentieth century dating for the site. The context of the material as well as the presence of scattered bits of

SITE 34-Cm-285

Cm-285 is a light but extensive artifact scatter (24,000 sq m) located on a colluvial ridge adjacent to the western flood plain of Blue Beaver Creek. The site area is under a light to moderate (30-40%) cover of mid-grass and a thin scatter of Post Oak and Blackjack Oak.

The site was totally collected in four, 30 m x 40 m units. Cm-285 has been badly eroded, deflated, and also damaged by a road running north to south through the site. Little possibility of <u>in situ</u> material exists, and therefore no further work is recommended.

Notes on the typology: A single projectile point was recovered from this site some years ago by a local amateur. The collector kindly loaned the artifact for examination. It is a medium sized dart point with an expanding stem, similar to the Ellis type. This offers scant evidence that the site may be Archaic.

SITE 34-Cm-286

Cm-286 is a scatter of historic materials dating to the World War I period, located along Bald Ridge Road just south of Dodge Hill. Historic materials extend along both sides of Bald Ridge Road for approximately 500 m. The context of this site is questionable. The material may have originally been deposited in the road construction and has since disturbed the dump area, or a dump area may have been used for borrow materials during the construction of Bald Ridge Road.

With regard to either of the above cases, Cm-286 has been badly disturbed by the construction of Bald Ridge Road, and no further work is recommended.

SITE 34-Cm-287

Cm-287 consists of the remains of four apparent structures. These remains consist of low, dry-stacked walls of native cobblestones. Artifacts present in the area are broken bottle glass, ceramics and portions of a cast iron stove.

The site is located below the southwest corner of Koehler Hill and covers a 40 by 70 m area. While some of the material is scattered on the ground surface, the building remnants appear to be undisturbed and possible <u>in situ</u> materials exist within at least one of the structures. The site lies at or very near the surface as indicated by the depth of a pothole in one of the buildings.

No collection was made from the site. Should the site come under adverse impacts testing is recommended so that the site might be better evaluated. In addition to testing, a detailed map of the structures and a complete surface collection should be made.

SITE 34-Cm-288

Cm-288 is a very small (4 sq m) concentration of lithic artifacts located on a rocky ridge above the west bank of Blue Beaver Creek, between two first-order tributaries of that stream. Artifacts were collected as one unit from a very tight enclosure of large granite boulders. Examination of nearby erosional exposures indicated that no in situ material is likely present. No further work at the site should be necessary.

SITE 34-Cm-289

Cm-289 consists of a dense but limited scatter of artifacts (400 sq m) on a low eroding bluff of the Wichita Formation existing on the east bank of the East Branch of Wolf Creek. The site area is under a low to moderate cover of mid-grass (30-50%).

The site was collected in four contiguous 10 m^2 units placed on the toe of the ride in the configuration of a square. The immediate area of this site is used as a exercise area for dry firing runs. The site area has been disturbed somewhat by vehicle traffic and resulting erosion.

No in situ material appears to be present at the site, and no further work is recommended.

SITE 34-Cm-290

Cm-290 is a large low-density surface site (10,000 sq m)

loose soils away from the road's surface. Because of the very limited amount of materials exposed at the time of each collection no grid units were imposed on the site area.

Cm-290 has been disturbed by vehicle traffic along the ridge road, some past traffic along the flood plain area, and at least one gun emplacement trench. The general area of this site is also the location of dry firing exercises, which have disturbed the ridge area to a slight degree. Artifacts in areas where horizontal away

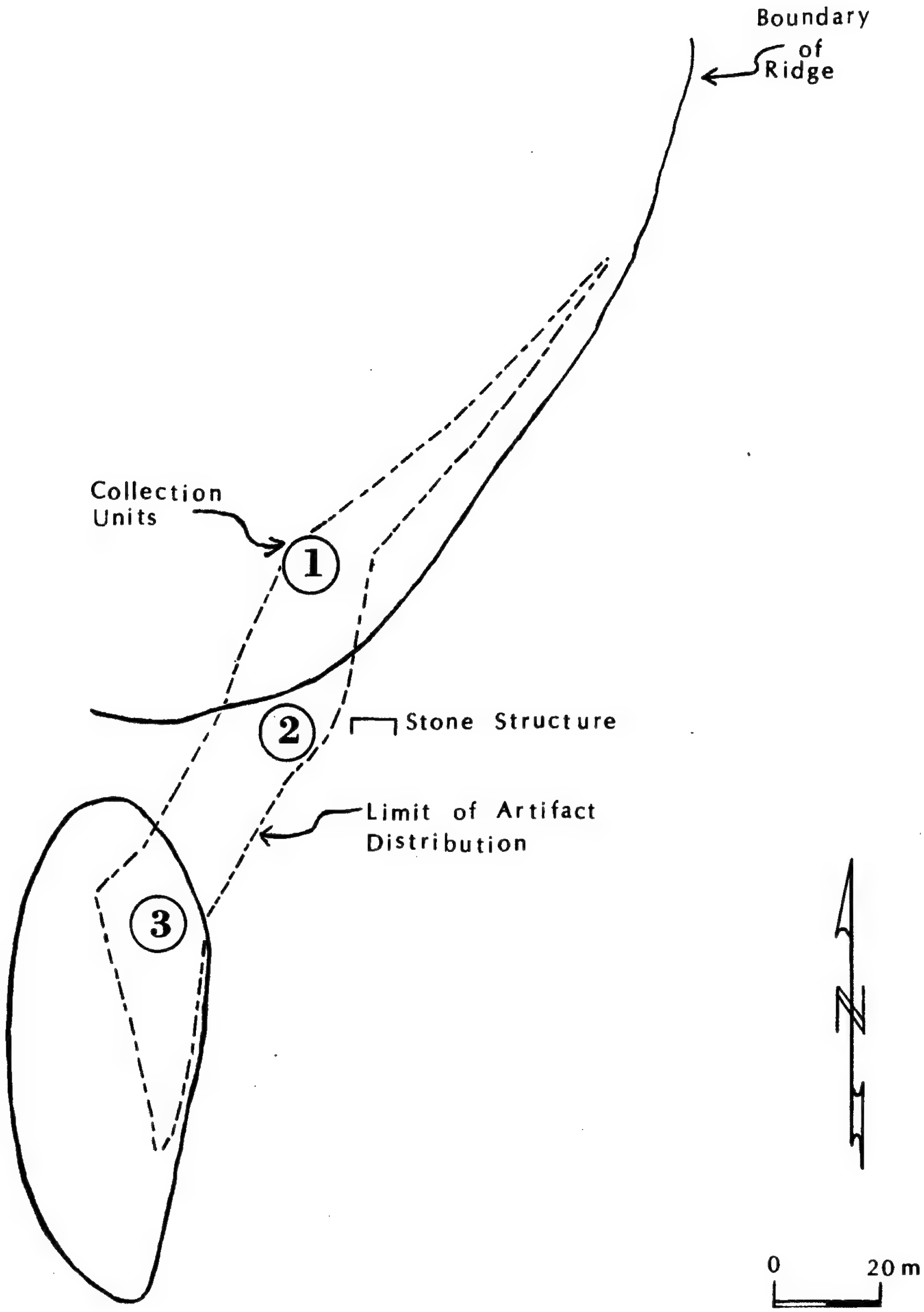


Figure 8-9. Map of site 34-Cm- 291

Creek. Patches of grass and forbs cover the otherwise highly eroded surface of the site. The site was totally collected without super-imposing grid units due to the low density of observable material and its obviously disturbed context.

Cm-292 has been very badly disturbed by activities related to several firing points in the site area. No further work is

SITE 34-Cm-295

Cm-295 consists of a surface and probably in situ deposit of lithic artifacts located on an old terrace of west Cache Creek. The artifacts (collected as a single unit) have been exposed by recent strip planting activities. The plowing associated with the strip planting has exposed artifacts apparently from a depth of up to about 30 cm. Quite abundant artifacts were observed when the site was initially located. Even more were found (but not collected) when the site was revisited and after the strip planting had been plowed again.

While artifacts were only observed in the plowed areas, in situ material should be present on either side of that zone. The minimum size of the site, based on the plowed exposures is about 1,800 sq m. Should the location or character of the strip planting be changed, or should additional activities be planned for the site area, testing should be carried out to fully document the depth and character of the archaeological deposits.

SITE 34 - Cm - 296

Cm-296 is a small (400 sq m) scatter of lithic artifacts located on the surface of Temple Knoll near the southeast corner of the Punchbowl. Artifacts occur primarily in areas where the rhyolite bedrock is exposed. The low numbers of artifacts as well as the disturbed context led to the collection of the site as a single unit.

No further work is warranted at this site since all of the archaeological materials appear to be in completely disturbed contexts.

SITE 34 - Cm-297

Cm-297 appears to be a small surface deposit of lithic artifacts located just north of Site Cm-295. As at the latter site, artifacts are being exposed in a strip planting. Soil conditions at this site however, do not suggest the possibility of in situ materials in the immediate vicinity of the strip planting area.

The artifacts reported here were collected as a single unit [illegible]

SITE 34-Cm-298

Cm-298 is an extensive surface scatter of artifacts located in the saddle of a broad, low, north-south ridge between a first-order drainage and a small second-order drainage west of the Cantonment. Artifacts are exposed in a highly disturbed, nearly circular area approximately 100 m in diameter, which surrounds a firing point. Where vegetation does exist, with the disturbed area, it is a light (10%) cover of mid-grasses.

Due to the nearly complete disturbance of exposed material an intensive collection was made without imposing grid units. Cm-298 has been extensively disturbed by the use of the location as a firing point, as well as resulting erosion. While relatively undisturbed portions of the site may remain to the north and west of the main site area, these should not contain any deep deposits, and should not warrant testing. Preservation of these areas for purposes of artifact patterning studies can be accomplished by maintaining them in a well vegetated state and by restricting vehicular traffic.

SITE 34-Cm-299

Cm-299 is a light, limited (400 sq m) artifact scatter located on a high bench of colluvium north of Deer Creek on the southeast slope of a high ridge of rhyolite near Mount Davidson. This bench area is covered with a scattered stand of Post Oak and a heavy (80%) growth of grass. Artifacts are exposed in vehicle tracks and paths, in which slight amounts of erosion have occurred. Due to the sparsity of observable materials an intensive collection of artifacts was made without superimposing grid units.

Cm-299 has apparently only been slightly disturbed by vehicle traffic and some foxholing. No further work is recommended for the site at the present time, although reevaluation should be made should the use of the site area intensify.

SITE 34 - Cm-300

Cm-300 is an apparently small artifact scatter located on a gentle slope of a low broad ridge above a first-order stream just west of the Ammo Depot. The site area is under a moderately heavy cover of mixed grasses (70%) and the only apparent disturbance is a set of vehicle tracks in which artifacts were observed. Due to the low amount of exposure the full extent of the site is unknown. A total collection was made of the artifacts appearing in the vehicle tracks.

No further work is recommended for Cm-300.

SITE 34 - Cm-301

Cm-301 is a large (8,000 sq m) surface site located on the crest and eastern flank of a low hill which is straddled by two small drainages which flow into Ninemile Beaver Creek. A recent

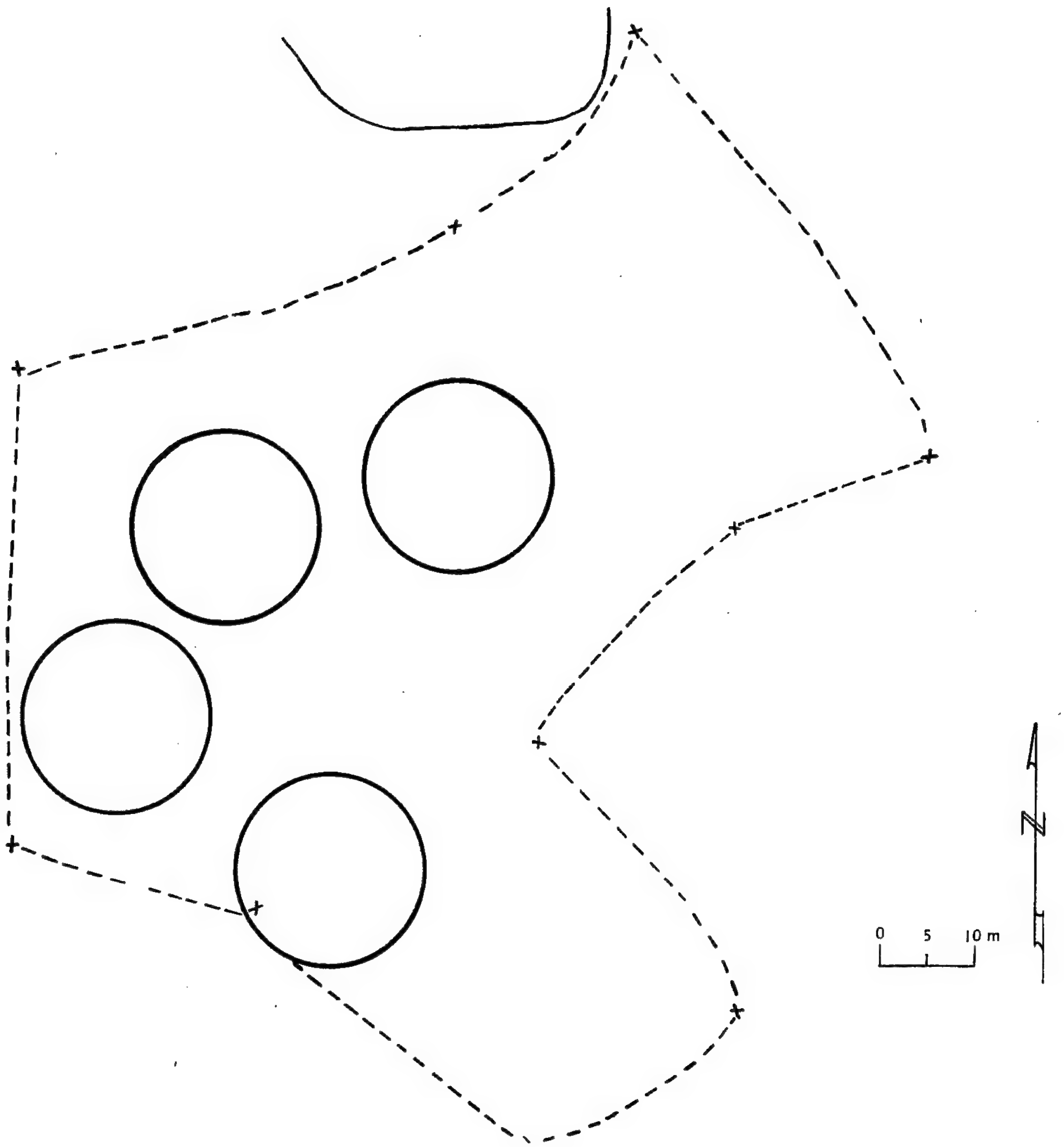


Figure 8-10. Map of Site 34-Cm-301, showing extent of the site and areas of surface collection.

SITE 34-Cm-303

Cm-303 is a fairly dense and extensive scatter of artifacts located on a bench just south of Fern Mountain on the Fort's north boundary, near a third-order stream which feeds Crater Creek. The bench is under a fairly heavy (40%) cover of mid-grass. Artifacts are exposed in areas of slight erosion in fairly dense concentrations and at the edge of areas of greater erosional ditches.

Cm-303 was collected in 5 point-radii units, each 10 m in radius. Units 1, 2, and 3 were located in areas of intense erosion while unit 4 and 5 were located in moderately eroded areas.

Cm-303 has been disturbed by vehicle traffic and bivouac activities. These two uses of the site area have apparently induced the erosion, particularly some of the heaviest erosion which seems related to vehicle traffic. Some portions of the site are probably undisturbed and would warrant testing. In particular, it is recommended that the area between units 4 and 5 be tested if traffic cannot be restricted from it.

Notes on the typology: Two projectile points were recovered from the surface. One is a small, triangular point (Fresno type) and the other is a basal portion of a large point with a slightly expanding stem. A large, bifacial, bevelled knife with an assymetric diamond shape was also located. (Figure 8-7: g). The small point and the knife suggest a Plains Village period for the site, while the dart point may reflect an isolated occurrence or multiple occupations.

SITE 34-Cm-304

Cm-304 occurs on a saddle between two hills overlooking Elmer Thomas Lake to the northeast, and a second-order stream to the west. The site consists of a raw material outcrop (Meers Quartzite) and a lithic scatter covering 7,500 sq m. A dense Post Oak-Blackjack Oak forest community occurs in the stream course but more sparsely on the hills and saddle. A moderate distribution of grasses also occurs on the saddle and hills.

Only one 40 sq m unit was collected from Cm-304. This was located over an outcrop of Meers Quartzite. A picnic area has been placed on the site as well as a road. These activities have caused shallow (less than 20 cm) disturbance in scattered areas. Because of the site's situation (i.e., on a saddle) sediments have not been deposited, but rather have been removed by erosion. The possibility of in situ deposits or artifacts is very low. No further work is recommended for Cm-304.

SITE 34–Cm–305

Cm–305 is a large (ca. 12,000 sq m) surface site located on a low ridge overlooking a small tributary of Ninemile Beaver Creek. The site has been extensively disturbed and eroded, but several concentrations of artifacts were recognized. These concentrations appear to be as much a product of the disturbance as any possible cultural phenomenon. The site area had been completely burned sometime just prior to its discovery but the surrounding vegetation consists of treeless growths of mixed grasses and forbs.

Three concentrations of artifacts were chosen for collection on the basis of their higher artifact density than the surrounding portions of the site. Each of the collected concentrations appeared to be the product of some artificial agent. Ten–meter radii were used about points set in the approximate centers of each cluster to define the collection area. Quadrats were used within two of these circular collection areas.

Site Cm–305 has been extensively disturbed by at least three agents. A firebreak has resulted in the disturbance and erosion of the northern portion of the site. A cool season planting area has

The total site area was systematically collected in five units. Two of these correspond to the firebreak and trail areas found on this site, while the other areas (1, 3 and 5) are those with much less disturbance. In situ materials are quite possibly present in the western portion of area 3 and in the northern portion of area 1. A vehicle rut in the latter area contained artifacts and bones of some unidentifiable small animal. The bones appear to be associated with the artifacts but testing would be necessary to document this.

Site Cm-306 has been quite extensively disturbed by the grading of the firebreak and trails, other scattered traffic, and also by erosion resulting from those factors. The areas of the site just mentioned as being likely areas of in situ deposits should either be sodded and protected from further traffic or they should be tested in order to evaluate the site for further research.

Notes on the typology: This assemblage has one of the highest percentages of tools of those recovered from Fort Sill. Three endscrapers and one sidescraper are present. Three projectile points are included among several other bifacial tools. One point is a small triangular piece (Fresno). Another is a distal fragment of a Fresno or other small triangular form. The third is rather atypical, having a triangular body which flares just at the base to form two basal tangs. One bifacial element is an alibates flake which has a finely shaped bifacial edge. This bifacial edge has been ground or worn heavily and a burin spall has partially removed about half its length. Overall, this assemblage has a late prehistoric character.

SITE 34-Cm-307

Cm-307 is a small (200 sq m) surface scatter of lithic artifacts located on the edge of a low ridge overlooking a small tributary of Ninemile Beaver Creek. The site consists of a low density scatter of lithic artifacts in an area which is currently being used as a hay lease area. While some artifacts may occur just within a thin soil mantle, no substantial in situ deposits appear to be present. Owing to the small size of the site as well as the low artifact density, the site was collected as a single unit.

No impacts on the site appear to have occurred, and the current hay lease activities pose no threat to the remaining deposits. No further work is recommended for the site.

SITE 34-Cm-308

Cm-308 is a very sparse scatter of lithic artifacts on the surface of a broad, low hill east of East Branch Wolf Creek. Total site area

is difficult to assess owing to heavy cover of mixed grasses, but a minimum size of about 6,000 sq m was discerned for the exposed areas. The site is truncated by McKenzie Hill Road, but no other disturbance was noted. The site is also not apparently the location of potentially disturbing activities, and thus no further work is deemed necessary. Reevaluation of the site, particularly with regard to artifact density, should probably be carried out should the use of the area change considerably in the future.

SITE 34-Cm-309

Cm-309 is a small, eroded surface site located on a low ridge overlooking a small intermittent tributary of Ninemile Beaver Creek. The ridge is near some wildlife plantings, but the undisturbed vegetation in the area is essentially a treeless prairie of mixed grasses and forbs. The main portion of the site, covering an area of approximately 120 sq m, is very eroded. Occasional artifacts were observed up to 50 m from the main concentration, but exposed areas suggest that no in situ deposits and no dense concentrations of artifacts occur away from the main concentration.

Owing to natural disturbance factors, the main concentration was collected as a single unit. No further work appears feasible at this site.

SITE 34-Cm-310

Cm-310 is a large (ca. 10,000 sq m) surface site located on a ridge overlooking East Branch Wolf Creek. The site is elongated, and most artifact exposures occur along the crest of the ridge where vehicle traffic has been high. The site is currently used as an observation point, and other disturbing agencies include a pipeline which traverses the site and a firebreak road which crosses its southern end. Artifacts appear to be present in the less disturbed portions of the site, particularly at its northern and southern ends.

Two circular collection areas were employed to recover a small sample of artifacts from the site; each of these was 10 m in diameter and was located over denser concentrations of artifacts in the eroded, disturbed portion of the site.

Preservation of the undisturbed portions of the site may be achieved by restricting traffic from those areas. Since sites in this area of the reservation may have functional significance relative to those in areas along the major streams, this avoidance is thus recommended in order to retain this as one of several representative sites for this area of the

Additional surface collections may be necessary should

Notes on the typology: Three of the projectile points are small triangular forms (Fresno). Another is a larger, contracting stemmed dart point made of alibates. The fifth is an atypical small form. Among the blank/preforms are two very well made lanceolate pieces which may well be knives. One of the preforms is a large one made on a flake of Alibates flint. This assemblage appears to possibly have both Archaic and later components.

SITE 34-Cm-313

Cm-313 is a moderately dense surface scatter (800 sq m) of artifacts and faunal material located along a first-order spring channel (feeding Ketch Creek) in a saddle between the main body of Rabbit Hill, about 500 m north of the north boundary road. Artifacts were observed along slightly eroded areas of the east bank of the stream channel, and on two areas of sheet erosion on the saddle. The area is under a light to moderate (10-50%) cover of mid-grass, as well as a moderately dense overstory of Post Oak and Blackjack Oak.

Cm-313 was almost totally collected with 2 point radii, one 10 m in radius and one 15 m in radius. In situ material is probably present just back toward the saddle from the stream and is most expected just up the channel in a heavily grassed and uneroded area. Cm-313 has been slightly disturbed by small amounts of apparently small-group bivouacking. It is not known if the area is presently used for the same purposes. If activity is to increase or be maintained in this area, either a protective top soil may be laid over the site area, after having been tested to allow further evaluation.

Notes on the typology: The single projectile point from this site is a large, broad piece with a short expanding stem, almost a corner-notched form. It is suggestive of an Archaic form, but these types also appear to occur in Woodland settings.

SITE 34-Cm-314

Cm-314 is a light, moderately extensive artifact scatter exposed along a 200 m length of dirt road cut into the southeast slope of Ketch Hill. The road exposure is to a depth of approximately 20 cm, and is without vegetation cover. The hill slopes in general are undisturbed and under a heavy cover of mixed grasses.

Cm-314 has not been collected. In situ material is probably present [illegible]

this site only if such testing might provide information from which inferences concerning significance based on context could be made for other similar sites, on similar slopes. Otherwise, it is recommended for this site only if such testing might provide information from which inferences concerning significance based on context could be made for other similar sites, on similar slopes. Otherwise, it is recommended that vehicle traffic on the slope be restricted to the road and that the road area be maintained to check the spread of erosion, which would widen the road, or eventually lead to a need for a new road, and thus further destroy possible in situ material.

SITE 34-Cm-315

Cm-315 is a light to dense, extensive scatter of lithic artifacts located in an area of extensive erosion on the north slope of a broad low ridge at the southern boundary of the fort, .5 km west of Blue Beaver Creek. Artifacts have been exposed along the banks of the eroded area, and appear to represent areas of in situ material which have recently eroded out of the banks. The eroded area is practically lacking any cover while the undisturbed soils surrounding the eroded area support a heavy (90%) cover of mid-grass.

Cm-315 was partially collected by laying out sets of units over eight main concentrations of artifacts. One set of sixteen 5 m^2 units was layed out lengthwise and side by side over the largest concentration of artifacts eroding from an approximately 40 m length of bank on the far east side of the erosional feature. Four 5 m radius, point-radii units were layed out over smaller concentrations of artifacts, and three 10 m radius, point radii units were layed out over larger concentrations of artifacts.

Cm-315 has been badly disturbed by erosion caused by firebreak construction and/or heavy vehicle traffic associated with Firing Points 607 and 608. A program of erosional control can be recommended for Cm-315 but given an assumption of continued use of the above firing points, and subsequent difficulty which would result from maintaining erosion controls, it may be considered easier to test this site. It is urged however, that one or both of the alternatives be taken as soon as possible given the apparent rates of erosion.

SITE 34-Cm-316

Cm-316 is a light limited artifact scatter (1,600 sq m) located on a knoll 200-300 m west of Post Oak Creek. Artifacts were observed

knoll, which is under a very light (10%) cover of mid-grass and a scatter of Post Oak and Blackjack Oak.

Cm-316 was collected with three point-radii units, each 10 m in radius. Two were placed at the knoll's top, while one was placed at the base of the south slope.

The knoll top at Cm-316 has been disturbed by heavy vehicle traffic. Given the apparent shallow nature of the soil on the knoll top and its previous disturbance no further work is recommended for the site.

SITE 34-Cm-317

Cm-317 is a moderately extensive, moderately dense artifact scatter (8,500 sq m) located on a high ridge top of the west bank

southern extremity of the site while one was collected near the northern extremity of the site.

Cm-318 is massively eroding due to apparently natural factors. In situ material may exist toward the east of the eroding areas, however, it is recommended that Cm-318 be more extensively collected in order to increase the proportion of the sample from the site.

SITE 34-Cm-319

Cm-319 consists of a probable dug-out on a second terrace above a lateral 200 m upstream from Post Oak Creek. It lies on the edge of the Creek bottomland timber. It is probable from the undisturbed nature of the dug-out slump that the structure remains are in situ.

Very few artifacts were found probably because of the ground cover. These included fragments of the lower neck portion of a ginger beer bottle. These were together about 10 m east of the slump but were not collected. Found about 80 m northeast of the slump and just above the stream channel was one complete, purpled glass jar of perhaps pickle or condiment type.

It is difficult to date a site by such fragmentary remains. However, the presence of these two vessels implies a turn-of-the-century or possibly even late nineteenth century dating. The absence of well-documented sites of this type particularly in this area make this site of significant potential importance. It is recommended, therefore, that, in the absence of demonstrable and immediate threat, activities potentially damaging to this site be restricted from the area. Should this in the future not be possible, testing should be conducted to confirm its dating and context.

SITE 34-Cm-320

Cm-320 is a lithic artifact scatter covering 2,800 sq m in a fire-break/road on the southeast side of Quanah Mountain. It is situated on a gradual slope overlooking a third-order tributary of Quanah Creek. This area is a Post Oak-Blackjack Oak forest interspersed with short grass clearings on a granite cobbley soil. Quartz is present on the site.

Cm-320 was collected in seven units laid out along the firebreak road. The units are 20 m long and vary from 18.5 m to 20.4 m wide (the road's width). A few isolated artifacts were collected west of the road, and mapped in place.

The cutting of the firebreak/road has incised a swath 40 cm below the surface and from 18.5 m to 20.4 m wide through the site. The site also appears to have been used for a bivouac area as foxholes and communication wire are nearby. No further work is recommended at Cm-320.

Notes on the typology: Of the six projectile points from this site four are triangular unnotched (Fresno) forms and two are side-notched triangular (Washita) forms. One alternately retouched piece appears to be a broken drill. The points from this site are of course strongly suggestive of a Plains Village age of the site.

SITE 34-Cm-321

Cm-321 is a light artifact scatter exposed along approximately 50 m of a dirt road cut down the center of a long, narrow, southerly-trending ridge on the west bank of Post Oak Creek. Artifacts were only observed in the road exposure although areas of shallow sheet erosion with light mid-grass covers exist to each side of the road, between clumps of Post Oak and Blackjack Oak. The site was totally collected without sectioning the road exposure due to the sparsity of materials.

Cm-321 has obviously been disturbed by the road cut exposure. Because in situ material probably exists even below shallow erosional areas, it is recommended that all vehicle traffic in the area be limited to the existing road.

SITE 34-Cm-26

Pig Farm Crossing, Cm-26, is a large lithic and bone scatter [illegible]

Chapter 9

RESOURCE UTILIZATION AND HUNTER-GATHERER DEMOGRAPHY: AN APPLICATION OF JOCHIM'S MODEL

by
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Introduction

In archaeology, the most popular and common use of models are as hypothetical constructs of a patterned system or situation. These constructs, based on inductive and deductive reasoning, often use real ethnographic and ecological data for their formulation. A successful model hopes to incorporate the essential variables and key relationships operating in the real world and predict certain aspects of the archaeological world on the basis of these variables. Archaeologists model every thing from the process of gathering raw lithic material for the production of stone tools and the resultant waste to subsistence and settlement systems or social systems of prehistoric populations (House, 1975:55-73; Thomas, 1972:761-704; Clarke, 1972:801-869).

Clarke (1972:2) has proposed that if explanations in archaeology are viewed as a "form of redescription which allows predictions to be made, then models as predictive forms of redescription are essential parts of archaeological explanations," and they function as "pieces of machinery" that relate observations to theories. Models can be viewed as a link in an inductive-deductive analytical chain as

is a large enough area to have easily supported a permanent population of hunters and gatherers or agriculturalists. Thus a more complete picture is offered by using a regional perspective.

Besides its direct application for the Fort Sill study, there are other reasons for developing the regional model. In southwest Oklahoma, archaeological research has been rather disjointed. The only evident goals have been the accurate recording of data, which is a valid goal but certainly not an all inclusive one. What has been lacking in southwest Oklahoma archaeology is long term research goals. This is not a new idea. Gumerman has proposed this for the southwest.

The model used for the Fort Sill study is a slightly modified version of Jochim's (1976) mathematical model predicting hunter-gatherer subsistence, settlement, and demographic systems. This model simulates the economic, site location and demographic choices of a group given that the food resources and other relevant data concerning foods are known. Further modifications have been made by the authors to incorporate domestic and nondomestic plant foods.

It seems that there are, in fact, two models implied in Jochim's or any mathematical model. The first is the abstract mathematical formulas composed of symbolic variables and functions which, in this case, model economic, settlement, and demographic systems of subsistence economy that should have an isomorphic relation to the real world (Moen, 1973:33). The second is the concrete, data model consisting of the Fort Sill information plugged into and generated from the abstract formulas. Each functions as a model on its own, albeit on different levels.

Churchman (1968) has outlined several procedures required for the analysis of a system. Jochim (1976:15) presented them in an order suitable to the organization of this report. These procedures include:

1. Identification of system goals;
2. Identification of the context or environment of the system;
3. Identification of means or resources available in the system's environment;
4. Identification of measure of performance for each means or resource.

Identification of the system's goals will be the first procedure undertaken. The identification of these goals represents the crux of

formulating a model of a system being analyzed and the most general implications in the test of such a model are that these goals guide the study system.

Identification of two spatial levels of environment in which pro-

1. Secure food and nonfood income. The attainment of a

The distinction between density and aggregation needs clarification. Aggregation (a) is the average number of individuals which can be found together in a group; density (d) is the number of individuals in a given unit of area. Given constant measures of the other resource attributes, the higher the density the more valuable a resource becomes.

Predictability is a very important factor in determining levels of potential resource utilization. Habitat restriction can be used as an index of predictability under the assumption that the smaller or the better defined a given resource's habitat, the easier it is to know its location at a given time. Habitat restriction (h) is measured as follows:

$$h = \left(\frac{t_1}{e_1} + \frac{t_2}{e_2} \cdots \frac{t_n}{e_n}\right)$$

where,

h = habitat restriction (predictability)
t = percentage of time spent in a given territory
e = size of territory relative to region

Thus, habitat restriction (predictability) increases as the resource spends more time in a given territory, and as the size of the territory decreases relative to the region's size. Thus animals with small territories, such as deer, are more predictable than animals with larger territories. Resources which spend all of their time in a given territory, such as plants or aquatic resources likewise are more predictable, even though the territory or habitat may be large.

Territory (t) is a complementary measure of a resource's predictability and represents a measure of the total area a given resource

It is felt that the conservative nature of scientific inquiry in general must make room for a process of successive estimation in the formulation of explanations, yet the same conservativeness must reassert itself to the fullest degree in testing the usefulness of formulated explanations.

The resource attribute data, including seasonal variations, considered relevant for the formulation of a model of resource utilization is presented in Appendix E. General information is described from ecological literature for each primary species or group of species to be included in a model of resource utilization, and tabulations of each of the above important resource measurements are presented. Care is taken to demonstrate the relative reliability of the guesses or estimates presented in these tabulations.

Measures of Performance

Performance measures are computation scores. Measures of performance are necessary to assess the importance of variations in resource attributes in terms of goals guiding decision-making processes in resource procurement. The major function of measures of performance will be to structure the attributes of each resource in the proper relationships with the goals of a system involving decisions

Considering the first goal, the formula indicates that a resource is of greater potential significance the greater its weight, nonfood yield, and that risk in its procurement decreases as density and habitat restrictions increase and as its territory and aggregation size decrease.

Considering the second goal, the formula indicates that a resource is less expensive to exploit when the weight, nonfood yield, and aggregation of the resource are maximized.

While most of the attribute relationships expressed above seem straightforward, the occurrence of resource aggregation in the formulas for both goals, and its opposite effects on rating resource procurement for each goal should be discussed.

The reconciliation of the goals are accomplished for the two goals in the following solution per resource:

$$\text{Total resource use } (\% \ ) = \frac{\left(\begin{array}{c}\text{percent resource use}\\ \text{scores for both goals}\end{array}\right)}{2}$$

In this manner the importances of each goal are treated equally.

This solution is held to be acceptable given that this method of determining resource use is based on a mixed-strategy solution. That is, it is believed more reasonable to assume that resource use essentially consists of a compromise of two different views of resources - their security and their yield (Jochim, 1976:27).

Modifications

Considerations must be given to several factors not directly related to resource attributes, but which have potential for significantly modifying system solutions in resource procurement (Jochim, 1976;30).

3. Decreased consideration of risk goal, given that the cost goal has been sufficiently satisfied during the period of consumption of stored resources.

In regard to the first of these implications ethnographic literature supports a conclusion, that for this region and set of groups which have occupied it, many of the major exploited or produced resources are storable. For simplicity in this initial model application, these factors are equalized here.

The second class of technological factors involves aids in resource procurement which decrease risks and costs of resource exploitation. Prehistorically and historically, the dog and the horse, and the travois are the prime examples of such factors effecting resource procurement on the plains. These factors greatly increase human mobility in relation to resource mobility and the consideration of these in "in" model modifications will be important in diachronically treating resource utilization and the structuring of economics, and human populations in the region. These modifications could be achieved through relating increased mobility of human populations to resource mobility by proportions equivalent to the increases in human mobility.

Another major class of resource attributes which have not been incorporated in the formulated model of resource procurement involve the relative spatial distributions of the resource. That is, the spatial distribution of any two prescribed resources may be totally disparate and thus a "spatial tension" may be realized between the procurement of these two resources in the proportions which the formulated model may imply (Jochim, 1976:31). In effect, such spatial tensions increase the cost of exploiting one resource over the other and so would indeed affect the proportional utilization of the two resources. This tension may lead to the emphasis of one resource over the other and depending on the resource attributes may lead to conservative exploitation of "low risk resources" or an extravagant exploitation of "greater yield resources" regardless of their high risk. Regarding such problems, Jochim (1976:31) has suggested that there may be some "threshold of importance," above which a resource procurement may tend to occupy almost all of a populations time and energy. For example, this may be the effect with the horses aid in transportation, which may boost bison use to a threshold at which it then becomes an even more proportionally used resource than just increased transportation has affected.

Also, it becomes important to consider the interplay of spatial tension of resource use across seasons and storability of resources.

Hypothetically, it would be most convenient if stored resources and procured resources in the season of consumption of stored resources fell in the same area. If, however, the procurement of resources in the season of possible resource storage and consumption involves a spatial tension, resources may not be stored, or the resources to be procured during the storable season may be less utilized.

Numerous other resource attributes have been neglected by the model formulated which cannot begin to be covered in the text of this discussion. Perhaps one of the single most important set of variables not considered would be variable relationships of natality and mortality, and growth rates of resource population given predation patterns. Such factors of consideration seem a matter of course in most studies in population ecology, and are definitely related to sustainable harvesting efficiencies.

The acceptance and practice of horticulture by groups inhabiting this region both prehistorically and ethnohistorically requires model modifications involving further consideration of both resource attributes and technological factors.

Jochim's model as a model of hunting and gathering resource procurement, which has been the major source of model formulation (actually a process of modifying his model), has not been formulated to handle aspects of decision making processes regarding agricultural procurement systems.

The form of modifications accommodating agricultural practices requires consideration beginning at the initial most level of model formulation. The first question must be: "Does the acceptance of agriculture require the recognition and score formulation of a completely new goal, which may come into consideration in a decision-making process of resource utilization?" Such a goal could for example involve separate consideration of maintenance cost of agricultural resources.

First it must be confessed that no search for such a third goal has been accomplished, exhausting the ethnographic literature on paleotechnic agriculturalists, such as Jochim has accomplished for the first two goals with regard to ethnographically known hunter and gatherers. However, based on Boserup's (1965) work concerning the conditions of growth of agricultural practices, it will be argued that the two most important goals in a decision making process of resource procure-

With regard to modifications of the previously formulated model pertaining to resource attributes of agricultural resources, it becomes necessary to simply add the consideration of these resources as a single resource group. This has been accomplished for a single situation in time estimating and averaging potential figures for the important resource attributes (weight, density and aggregation) from ethnographic information and treating habitat restriction as unity, since fields are planted and their locations known.

These potentials only represent estimated averages of resource potential given a single point in time, without consideration of historical and technological and demographic factors effecting agricultural production. If time permitted, model modifications could be achieved to more continuously study systems of agricultural resource procurement of the region as they would be affected by such factors as an important research interest in and of itself.

Demographic Arrangement. Subsystem II

The following section concerns model aspects involving the spatial arrangement of human populations, as a second subsystem related to meeting the goals of a decision process of resource procurement, and the relative proportions of resource use identified in consideration of subsystem one. Consideration is given to location and duration of populations of settlements as they are influenced by predicted subsistence patterns. Toward these ends, the section involves the presentation and discussion of several modeling aspects which regard the spatial arrangement of human populations that have been presented as operating in separate subsystems by Jochim (1976). The perspective taken here is that these modeling aspects as interrelated to be best handled with as little incongruence as possible. Additionally, consideration and necessary reconciliation are offered in regard to the logic of Jochim's (1976) and Wilmsen's (1974) modeling of population aggregation, as one aspect of the spatial arrangement of human populations.

Once again, the identification of goals, resource measures of performance, and management considerations will follow the previously suggested outline for the analysis of a system.

Goals

spatial arrangement of human populations include:

1. The provision of adequate levels of food for the population in predetermined proportions, at high security and low cost.
2. The achievement of appropriate proximities to important economic resources.
3. The insurance of social interaction and reproductive viability through population aggregation.

The first of these goals is a general implication of the goals discussed in the preceding section. That the primary goal of a system would be the provision of food for all its members, thus enabling the system to maintain itself, will not be questioned. However, the determinants of population densities supported in such systems have been widely discussed (Jochim, 1976:66). An important point of the literature on this topic is the contrast of carrying capacity and realized capacity: realized capacities depend on cultural definitions of carrying capacity. The implications of such contrasts manifest themselves with the identification of goals reliant on the recognition of the availability of resources and the efficiency of their procurement in culturally predetermined proportions. Proportions of resources to be obtained significantly effect the arrangement of a human population regarding the location and size of the co-residing group (Jochim, 1976:67). Economic decisions directly act as depressant forces against human carrying capacities.

The second two goals express more specific aspects of the effects of the first goal. Locations of settlements are positioned to achieve appropriate proximities to important resources, and populations are arranged to assure social interaction and reproductive viability of the group.

Jochim (1976:66-70) further demonstrates the existence of the second goal through the similar use of ethnographic literature and relates human population aggregation as a function of resource distribution. Jochim's points are that group aggregation, or increased [illegible]

operating in population aggregation, he never gives this goal full and separate attention. Wilmsen, however, has modeled population aggregation based on the desirability of social interaction and necessity of reproductive viability, as being dependent on the relative predictability of procured resources.

Wilmsen's model of spatial organization is based on a previously formulated ecological model of social spacing presented by Horn (1968). The use of this model suggests that abundant stable resources are best exploited by minimal work units and that more unpredictable, although abundant, resources are best exploited from control locations of population aggregation. Such centralized populations can support task groups which can best locate and exploit these types of resources and thus increase potential yields (Wilmsen, 1973:6-9). Jochim has implied that periods of the least stable resources should determine aggregation as well as their abundance, but he has given no specific detailed consideration of a goal of yield increases through aggregation in goal identification, performance scores or management considerations.

Thus, while Jochim suggests aggregation is based on resource abundances which allow population aggregation, Wilmsen suggests that aggregation is based on potential resource abundances aggregation may provide. Both researchers, and others, are in agreement concerning the desirability, if not the necessity, of aggregation.

In summary, a reconciliation of the goals of population aggregation postulated by these two researchers can be made. Population aggregation should occur when the two following goals can be best realized: 1) resource abundance allowing increased group size, and 2) potentially increasable resource abundance necessitating increased group size. This reconciliation should offer a better perspective of the goals of population aggregation than either Jochim's or Wilmsen's separate works, and should thus be of value in further formulations of performance scores and management considerations.

Resources

The primary resources of a subsystem of demographic arrangement are the factors considered in making decisions of when and where to move settlements and in what number they can be populated. Basically, these factors concern the spatial distributions of the various biotic resources handled in the formulated model, although they should also include the addition of two more important resources - water and lithic material. Consideration of each of these resource factors may

be viewed through system goals as resulting in a relative "pull" for each resource. The "pull" of these resources in turn manifests itself in the location of settlement, or areas of combined or specific activities related to resource use.

Measures of Performance

Measures of performance for the decision-making subsystem of demographic arrangement must consider resource "pulls" and thus permit the evaluation of site location and duration of occupations (Jochim, 1976:52). Measures for maximum feasible human population densities can also be calculated according to resource use decisions. Additionally measures may be provided for potential human aggregation based on decisions of resource use. Both these sets of calculations can, in turn, be related to areas necessary for resource procurement, given further consideration of absolute group size.

Some method of determining the "pull" of each resource must be formulated for the evaluation of a decision-making process concerning site location. First, it is useful to examine Jochim's (1976:53) conclusion from ethnographic literature that there is a set of hierarchial principles apparently structuring spatial behavior. The major principle is that resources vary in their importance to site location or "pull" according to their security, such that the greater the security of resource the greater its "pull" on settlement location (Jochim, 1976:53). A more general conclusion may be that whenever possible sites are located to provide access to more general areas of high risk and yield resources, but that the specific locations of sites are on or near high-security resources (Jochim, 1976:53). Likewise, some locations of activities will be near water and/or sources of lithic material as these may be considered high-security resources (though no specific measures have been given them in the formulated model).

The hierarchy of importance of resources to settlement decisions structures a hierarchial spatial organization around a site which includes three levels. These levels consist of 1) an immediate site location, 2) a nearby "female" activity field, and 3) a further "male" activity field (Jochim, 1976:55). These levels have likewise been termed "mini-", "micro-", and "macro-catchments" (Jarman, 1972).

Mini-catchments may involve site-specific activities associated with water, fuel or lithic materials. Micro-catchments involve resources of low mobility and thus relatively high security, and usually are exploited by women for vegetable foods or small game.

Macro-catchments involve the procurement of resources of the greatest mobility, big game, and usually exploited by males. The actual size and shape of these levels of procurement areas depends on topography, density, and seasonal use proportions of the various resources (although the most important is not necessarily the closest) in a given region (Jochim, 1976:55). After later formulations based on group size are achieved, actual distances can be related to each of these catchment levels.

In terms of measures for the relative pull of various resources, a gravity model is one of the most attractive devices for interrelating distance, mass, and interaction. A gravity model which attempts to model site location is presented below (from Jochim, 1976:56-60):

$$R^2 = \frac{wna}{\%U}$$

where R^2 equals the relative magnitude of distance ("pull") to a resource and (%U) equals the proportional use of a resource as previously determined.

Thus, the gravity model predicts relative distances to resources and expresses that site locations will be closer to 1) less mobile resources, 2) more dense resources, and 3) less clustered or aggregated resources (Jochim, 1976:60). The results of such calculations may then be evaluated in terms of the different sized catchments or activity fields involved in resource procurement previously discussed.

The pull of particular resource communities may be evaluated by multiplying the reciprocal of the relative distance ($1/R^2$) of a resource times its density. Thus the formula:

$$\left(\frac{1}{R^2}\right) d$$

will relate a strength of pull (opposite of relative distance) to a particular resource community.

The duration of occupations of site locations must also be discussed in relationship to the relative pull of resources. Perhaps the most direct factors relating to the duration of occupations concern the exhaustion of local resources or the satisfaction of predetermined levels of needed yields, possible resource densities, limits of human mobility, and the population sizes of the co-residing group (Jochim, 1976:60). Then again, the satisfaction of predetermined levels of needed yields

depends solely on the level of yield actually determined as needed. Some resources, such as lithic materials may be relatively easily procured to levels of predetermined need, and activity locations at source areas of lithic material would be relatively short. Other resources such as nut or vegetable resources both may require many days of effort and provide many days sustenance. Thus, occupations of sites in locations providing proximity to such resources will be of longer durations.

Responses to resource pull in other areas may also affect the duration of occupations. The timing of changes of resource pulls across economic seasons should be evident from the previously formulated resource use schedule. That is, changes in season through a year mark appearances of new resources, and therefore mark changes in resource attributes which importantly affect settlement location (Jochim, 1976:60).

Culturally defined carrying capacities can be formulated through calculating the biomass of each major resource and then considering proportional dietary contributions based on estimates of caloric needs. The following formula expresses a calculation for maximum supportable population for a given resource and its predetermined proportional dietary contributions (from Jochim, 1976:71):

$$cc = \frac{dscf \times w/p}{y}$$

where,

cc = carrying capacity (per sq. km.)
d = density of resource (per sq. km.)
s = spatial area involved (sq. km.)
c = calories per kilogram
w = edible weight
f = harvesting efficiency (decimal percentage)
p = proportion of yearly diet (decimal percentage)
y = estimated yearly caloric requirement for one person (at 2000 c per day – 730,000 c per year)

This formulation may proceed for each major resource or class of resources, and thus carrying capacity may be defined for each resource. The lowest figure of these results may be taken as the maximum feasible population density according to resource use calculations, since it is assumed that each predetermined dietary [illegible]

One additional means for calculating carrying capacities based on agricultural practices can be presented (from Rappaport 1968:285 and Carneiro, 1956)

$$cc = \frac{(T/R+Y) \times Y}{A}$$

where

cc = carrying capacity
T = total usable land
R = length of fallow in years
Y = length of cropping period in years
A = area of cultivated land required to provide average individual with the amount of food ordinarily derived from cultivated plants per year

This formula can be used as a complementary calculation for carrying capacity for agricultural economies and should provide some important comparison with Jochim's formula for carrying capacity. This point should particularly hold given possible increases in carrying capacity with the introduction of agriculture or the operation of two separate economies in a region.

Jochim (1976:73) also presents a measure reflecting potential group size or aggregation. This measure reasons that relative group size (g) will be proportional to the abundance of spatially concentrated resources and the amounts these resources are used. A modification of this formula according to earlier modifications for abundance allowing aggregation is, for each season:

$$g_1 = \sum_1 ((w\ nadh/t) \times p)$$

This formula presents a figure by which potential aggregation in each season can be compared. Relating this modeled expression for potential aggregation back to the previous goals section for the demographic subsystem, the measure may be viewed as expressing potentials for aggregation, given predictable low risk resource procurement. That is, this measure relates periods of time during which resource attributes will best allow population aggregation.

This measure can be contrasted with situations in which aggregation can be viewed as being beneficial given possible advantages aggregation will have for procurement of high risk, high yield resources.

In the latter case, the best measure for aggregation potentials or relative group size in terms of increasing yields for each season is:

$$g_2 = \sum\left(\left(\frac{\sum \text{minimum cost score}}{\sum \text{secure income score}}\right) \times p\right)$$

or,

$$g_2 = \sum\left(\left(\frac{\sum (wna)}{\sum (wndh/ta)}\right) \times p\right)$$

This formula expresses that population aggregation will be most beneficial in increasing resource yields the higher the sum of minimum cost scores, the lower the sum of resource scores for security of income, and the greater the use of a resource.

Population aggregation may then be best measured through a reconciliation of the two separate goal measures regarding population aggregation. This reconciliation may actually be viewed as a management consideration but is most easily included here. Such a reconciliation is represented in the following formula, where for each season and for each goal:

$$\%g = \frac{\text{seasonal score for one goal}}{\text{seasonal scores for one goal} \times 100}$$

and for two goals,

$$\%\ \text{total}\ g = \frac{(\text{n seasons score \%'s for two goals of aggregation potential})}{n}$$

In this fashion, equal importance has been assigned to each of the separate goal measures for population aggregation toward a final decision making process in the subsystem solutions for aggregation.

The objectives of group aggregation should be considered to be effected by three additional factors. First, ...

Second, aggregation may be affected by travel time (Jochim, 1976: 76). That is, total aggregation sizes may be reduced by the extent to which the total population is dispersed. Thus aggregation occurs, but overall size of aggregates may be reduced.

Third, the strength of needs and desires for social interaction could be viewed to vary, given group sizes in previous seasons, as determined by resource attributes (Jochim, 1976:77). Thus, the strength of needs and desires for social interaction may be the greatest during the first season which allows or requires population aggregation following the season in which a population is at its maximum and/or practicing reduced group sizes.

In conclusion, these three factors will limit the attainment of the largest aggregation potentials. The lowest potentials will be taken to indicate the minimum levels of group size, and the size of local organizations (i.e., local or micro-bands).

Based on the above measures of performance for carrying capacity and aggregation potential, performance measures regarding group size and amounts of areas required to support such groups can be suggested. These measures are to be based on the assumption that group size or aggregation will tend to increase whenever possible to its upper limits.

Management Considerations

In the formulation of demographic decisions, all previously described goals are important (Jochim, 1976:77). For site location and duration of occupation, the most important considerations are the structuring of spatial satisfactions of objectives of resource utiliza-
tion as prescribed by the goals of a resource use schedule (Jochim,

to the following three extra factors affecting population aggregation: 1) limitations of areas supporting aggregation, 2) transportation costs, and 3) previous group sizes.

Once "separate" considerations have been reconciled for site location and group size, management considerations should, in turn, feed back into the relationships of site location and group size to "redetermine" locations (especially duration of occupations and frequencies of moves) and affect actual areas involved in resource procurement.

Resource Procurement Activities

As a decision making system, the resources available to systems of resources procurement are the means used in decision making processes. Based on ethnographic observations of the importance of knowledge concerning resources, a model of resource utilization can be viewed as an adaptation of predatory human behavior to resource behaviors in order to meet predetermined goals of the system (Jochim, 1976:22-23).

Various aspects of resource procurement and resource behavior which are relevant in decision making processes must then be described. Descriptions of resource procurement activities may be presented from ethnographic literature and can often be given perspective in time from previously collected archaeological data. The ground work for procurement activity descriptions has proceeded from the compiliation of ethnographic descriptions of resource utilization presented in Chapter 3.

Application

Application of Jochim's model to both southwest Oklahoma and Fort Sill has been carried out using procedures discussed above. Data and estimated data values for the application are presented and discussed in Chapters 3 and Appendix E. These sections should be referred to prior to consideration of the following application.

The results of the application of Jochim's model are presented in Tables 9-1 through 9-3. These tables reflect consideration of a hypothetical hunter-gatherer economy. The modeled percent use and pulls are indicated in Table 9-1. Considering the percent use first, several aspects of the model are significant for the southwest Oklahoma region.

The consistently high use of bison is most prominant and the most expected. The size of bison alone makes them a highly attractive resource. This is indicated clearly in the model by the low variability across seasons in the expected use of bison. Other large game, such as elk and deer are insignificant when compared to the expected figures for bison. A hypothetical decrease or absence of bison from the regional habitat would clearly have a striking effect on the model. With the exception of elk, substitution of any other set of resources for bison would obviously entail quite radically different procurement strategies. (See

Table 9-1.) Small game exhibits strikingly high expected use in the

With the exception of low root food use in spring and winter, plant use is restricted to summer and fall seasons in the model. Fruits and roots are especially high in the summer, while nuts clearly dominate the non-bison expected use in the fall. It should be recalled at this point that storage of any of these resources has not been considered in this application.

In terms of expected use, then, the model for the region is quite straightforward. High use of animal resources, primarily bison and small game are expected for the spring and winter. Plant resources are much more important during the summer and fall, while bison remains a still dominant aspect of the modelled economy.

Demographic arrangement is first considered by the calculation of pulls, as shown in Table 9-1. These indices reflect site location situations on a sub-regional level and therefore appear to have more significance for a study area such as Fort Sill. Markedly weaker pulls may be observed for all of the megafauna in all seasons in contrast to the much stronger pulls for the less mobile resources. The most significant patterns here should be those determined by very strong pulls associated with high expected use (Table 9-2). The near omnipresence of small game excludes this resource from importance in this respect. Notable patterns are those such as proximity to mussel in the winter and spring, fruits and roots in the summer and nuts in the fall. Each of the expected uses and pulls associated with these resources suggest potentially important aspects of site locations. Very low pulls for megafauna in the summer reflect adjustments expected given high plant resource utilization. Overall, quite fluid settlement patterns might be anticipated by the high use and low pull of bison, with more specific site locations expected during the summer and fall. The population aggregation potentials calculated for the same seasons follow this pattern (Table 9-2). Very low aggregation potentials are observed in the expected values for spring and winter. Much higher aggregation potentials in the summer and fall may be attributed to the expected use of abundant plant resources.

Table 9-2. Population Aggregation Potentials for Hypothetical Hunting-Gathering Economy in the Southwestern Oklahoma Region.

Economy	SEASON			
	Spring	Summer	Fall	Winter
Hunting-Gathering	2.40	39.20	55.32	3.00

Table 9-3. Modeled Carrying Capacities of the Southwestern Oklahoma Region and Fort Sill for the Hypothetical Hunter-Gatherer Economy.

	SEASON			
	Spring	Summer	Fall	Winter
Region				
density (persons/km^2)	.04	.12	3.9	.04
estimated population potential	1,794	5,437	172,855	1,799
Fort Sill				
density (persons/km^2)	.05	.15	4.9	.05
estimated population potential	19	59	1,1881	19

Carrying capacities and estimated population potentials have been calculated by season for both the region and Fort Sill (Table 9-3). These expected values follow the previous patterns of aggregation potentials. Fall is the most productive season because of nut availability. The limiting seasons are of course spring and winter, with a modest .04 persons/sp. km. expected at the regional level. It should be noted that the limiting estimated population potential for Fort Sill (19 persons) is approximately the size of a small band. An implication is that under

Chapter 10

CATCHMENT ANALYSIS OF ARCHEOLOGICAL SITES AT FORT SILL: A PRELIMINARY REPORT

by

C. Reid Ferring

Introduction

The preceding chapter has presented an application of a resource utilization and demographic model to the southwest Oklahoma and Fort Sill settings. The goal of the modeling procedure was to generate implications which could be of use in the structuring of future research at Fort Sill and in the region. Several pertinant implications may be drawn from the model which have relevance to the study of hunter-gatherer subsistence and demography. The importance of these research goals bears on the management of cultural resources at Fort Sill and in other areas of the region since they help form a framework for the interpretation of site significance.

Another analytical endeavor was undertaken as part of the reconnaissance which could complement the preceding modeling. This chapter will briefly present several aspects of site catchment studies which were begun at the reconnaissance phase. Site catchment studies were seen as a potentially useful tool for the analysis of intersite variability. The demographic and subsistence related aspects of catchment analysis are only recently being explored, yet they are theoretically appealing in those areas of archaeological analysis. Applications to an extensive series of sites are at this time unknown to the author; the complexity of such analyses may be easily anticipated however, and the present discussion will indicate only several of the important considerations involved in a full study. The conclusions presented here are substantially less than those that were hoped for. These analyses were undertaken only late in the project when limited computer facilities became available. More complete studies were obviated by an exhaustion of those facilities. Certain data sets as well as a few observations on limited analyses are presented here in order to enable continued studies at Fort Sill as well as elsewhere.

Catchment analysis was first generally introduced to the archaeological literature by two consecutive studies in the Levant (Vita-Finzi and Higgs, 1970; Higgs and Vita-Finzi, 1972). In the former paper the term "site catchment analysis" was introduced to describe the "study of the

relationships between technology and those natural resources lying within economic range of individual sites" (Vita-Finzi and Higgs, 1970: 5). The authors emphasized the importance of the seasonally variable resource composition of an energy defined territory about a site as attributes of that site. These resource attributes were considered mainly in the inquiry into possible origins of agricultural and pastoral economies. Conceptually this approach is exceedingly straightforward. Vita-Finzi and Higgs considered catchments of several sites which were defined by the distance which could be covered in a two hour walk. The composition of these catchments was compared, giving attention to habitats of pertinant mammals, percentage of arable land, etc. Differences among the sites suggested either seasonal movements to maintain resource procurement levels or seasonal variability in procurement strategies would have been necessary aspects of the economies involved.

The theoretical contribution of Vita-Finzi and Higgs is quite apparent and has relevance to many archaeological settings. The measurement of resources within a prescribed distance from a site and their analysis as site attributes appears to be an almost inevitable aspect of subsistence settlement studies. Methodologically, however, their approach was

Flannery's message is that catchment definition is highly relative when multiple resources are considered. The same conclusion could be drawn from Jochim's (1976) "pull" calculations. Certain abundant, dense, non-mobile resources have strong geographic relationships to site locations and of course to site specific activities. Concentrated plant resources are a prime example. Other dense but mobile resources are a prime example. Other dense but mobile resources, such as bison, have a less definite relationship to site location, and perhaps suggest the necessity of satellite activity loci about the sites located near resources with strong "pulls." Jochim's approach is similar to Flannery's in that he accounts for the kind and proportional use of various resources while considering site catchments. The obvious difference is that Jochim has modeled his resource use patterns while Flannery has determined them empirically. There is little doubt as to which determination proceedure is the most attractive, but unfortunately most research situations are not as well endowed as the Tehuacan Valley.

The approach taken here is similar to that of Vita-Finzi and Higgs in that a catchment of a predetermined size (measured in energy distance) is employed. This approach is mandated by the fact that virtually no subsistence data are available from the sites. By predetermining the size of the catchments, an a priori limitation of procurement distance is being imposed. Evaluation of the procurement radii obviously would require analysis of subsistence data from the sites, but until those data are available, the present approach may be considered similar to the recognition of "on site" versus "near site" resources (Gumerman, 1972).

There are obvious drawbacks to the use of predetermined site catchment sizes as may be inferred from both Flannery's and Jochim's discussions. These drawbacks may be measured conceptually, however, and are mainly limited to the detection and measurement of longer distance procurement. In a small study area like Fort Sill, on the other hand, it seems reasonable to use small catchments as site attributes for the purpose of intersite analysis. This is in keeping with the treatment of materials within the study area, while it has been emphasized elsewhere in this report that a much different framework would have to be used on a regional level.

The goal of the present study was to provide a set of resource related attributes for each site which were defined by consideration of aspects of the modern environment and which were associated with the site by reference to a catchment. These site attributes were viewed as important adjuncts to the material culture attributes acquired by surface collection, particularly when the acquisition of excavated data could be anticipated during some later management phase of research. In the

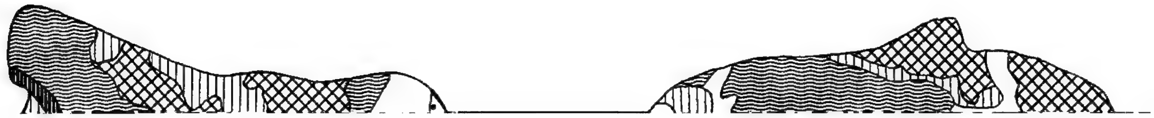
absence of actual subsistence data, the modern resource associations of the sites were viewed as a potentially informative tool for the analysis of intersite variability. The products of such analysis should include posited site functions, hopefully with some temporal framework, which could be seriously investigated during later researches through the recovery of actual subsistence data. Recovery of such data from a few well dated sites could lead to the improved interpretation of surface sites later on.

Methodology

Construction of the site catchments was done on the basis of a half hours walk from each site. The number of sites obviated the possibility of actual determinations. Thus trial walks up various streams, and up and down slopes were conducted to arrive at average distance qualifications. These were then plotted on topographic maps with adjustments made for each contour line crossed. Major terrain variations were adjusted for in the drawing of radii from each site, and the actual perimeter of each half hour catchment was interpolated after drawing about six radii. These catchments were superimposed over a soils map of Fort Sill (Figure 10-1). Counting of zipatone dots provided a measure of each soil type present in each catchment. Within each half hour catchment a ten minute catchment was defined along the same lines (Figure 10-1). This micro-catchment was deemed useful for possible

Table 10-1. Catchment composition of selected sites at Fort Sill. Figures shown are in sq km. See text for definition of soil types.

SITE Cm-	SOIL 1	SOIL 2	SOIL 3	SOIL 4	TOTAL AREA
233	.020	0	5.454	5.624	11.098
69	.424	1.853	3.170	.440	5.887
68	.424	1.853	3.170	.440	5.887
67	.424	1.853	3.170	.440	5.887
234	.145	.268	5.143	1.934	7.490
235	0	.467	6.383	2.190	9.041
58	0	2.921	2.812	1.030	7.363
236	.145	.268	5.143	1.934	7.490
74	.147	.474	8.113	1.630	10.365
239	0	1.535	3.839	1.692	7.066
93	0	.129	8.270	2.025	10.424
240	0	.129	8.270	2.025	10.424
241	0	.129	8.270	2.025	10.424
242	0	.392	5.057	1.485	6.934
92	0	.671	7.485	2.190	10.347
247	0	0	7.880	2.293	10.172
249	.020	0	5.454	5.624	11.098
20	.041	0	4.785	4.943	9.769
276	0	0	4.515	2.132	6.646
277	0	0	4.515	2.132	6.646
72	0	3.508	3.676	.222	7.406
71	0	3.508	3.676	.222	7.406
280	0	.297	6.619	3.460	10.376
282	0	.288	6.794	3.125	10.206
283	.088	2.236	4.356	1.703	8.383
285	.088	2.236	4.356	1.703	8.383
65	0	3.451	3.120	.676	7.247
291	0	.658	5.542	1.676	7.875
295	0	0	5.633	3.016	8.649
298	0	0	11.651	.907	12.558
301	0	0	8.324	2.372	10.696
303	0	1.853	1.424	1.061	4.338
305	0	0	10.850	1.395	12.245
306	.925	.143	8.118	.553	9.739
308	0	0	6.533	1.622	8.054
310	.027	0	8.039	1.179	9.245
312	0	1.224	3.964	1.204	6.392
313	0	1.224	3.964	1.204	6.392
315	0	0	3.932	.791	4.723
316	0	.671	7.485	2.290	10.347
317	0	0	5.689	2.358	8.048
318	0	0	7.295	2.070	9.365
320	0	1.045	3.132	1.315	5.492
118	0	.467	6.383	2.190	9.041



These were estimated to be half of the areas of the following soil types: Granite cobbly, Lawton and Rocky-stony. The "grassland" component was computed as all of the non-alluvial soils less the "upland" areas.

Table 10-2. Seasonal faunal densities used in catchment analysis at Fort Sill. Densities shown are individuals per sq. km.

	GRASSLAND	UPLAND	ALLUVIAL
SPRING			
Bison	2.70	.37	1.25
Elk	.24	1.20	1.00
Deer	.95	14.50	13.20
SUMMER			
[illegible]	[illegible]	[illegible]	[illegible]
Elk	.36	.59	.54
Deer	.76	15.40	13.70
FALL			
Bison	2.70	.37	1.25
Elk	.24	1.20	1.00
Deer	.57	17.50	14.70
WINTER			
Bison	2.70	.37	1.25
Elk	.12	1.90	1.70
Deer	.48	17.50	15.80

Seasonal densities for both faunal and floral resources were next calculated, using modifications of the regional data presented in Appendix E. (These estimates were computed with the assistance of Britt Bousman). Varying densities were used in most cases for different seasons, reflecting habits of the particular species (Table 10-2). Uniform densities of 53 animals per sq km were used for small game for each season. These fauna densities were then transformed into caloric values. This was accomplished by estimating an average weight per individual, an average caloric value per kilogram of the usable portions of that weight, and the product of those two factors with the combined density of the species in a given catchment. The figures used for these calculations are shown in Table 10-3.

Table 10-3. Weight and caloric indices used in estimation of faunal resource potential for site catchments at Fort Sill.

SPECIES	Usable Weight/individual (kg)	Calories/kg	Calories/ Individual
Bison	397	2500	992,500
Elk	162	2500	405,000
Deer	40	2500	100,000
Small Game	0.65	1600	1,040

Plant food densities were calculated in the same fashion as the animal resources. Fruits, roots and nuts were considered. Densities for each category had to be very roughly estimated from the survey data provided by Robertson and Hoestenbach (this volume). Seperate nut tree densities were calculated for each major stream using the relative frequency of the nut-bearing species and the estimated size of the bitterlich plots. These nut-bearing tree densities ranged from 693 trees/sq km on Post Oak Creek to 191 trees/sq km along the lower portion of East Cache Creek. Average nut bearing tree densities for all streams is estimated at 468 trees/sq km. Densities of root and fruit bearing plants were more crudely estimated for each soil group and for each major stream. Fruit bearing species were only noted for the fall and summer seasons. Overall densities were calculated for the summer fruit species with estimates of 800 plants/sp km for the "upland" soils, 5000 plants/sq km for limestone cobbly and Foard soils. Modifications of this basic density figure were computed for each major stream which had more species represented. The same procedure was carried out for edible root bearing plants.

Transformations of these densities for fruits, roots and nuts were computed so that the catchment values for each resource group was expressed in calories. The figures used for these transformations are indicated in Table 10-4.

Summed resource totals for each site catchment were prepared for both "bison present" and "bison absent" situations (Tables 10-5, 10-6). These tables indicate the total estimated plant and animal resources within the catchment as expressed in thousands of calories. Such calculations obviously need to be supplemented by nutritional factors.

Table 10-5. Seasonal food resources calculated for selected site catchments at Fort Sill. Figures are in thousands of calories.

		SEASON		
SITE Cm-	SPRING	SUMMER	FALL	WINTER
233	32900	33019	59978	35564
69	15981	16676	20739	17244
68	15981	16676	20739	17244
67	'15981	16676	20739	17244
234	21440	21925	40098	22765
235	25811	26570	55690	27469
58	20357	20742	36507	22315
236	21440	21925	40098	22765
74	29680	30713	45403	30710
239	19720	20228	43061	21541
93	28994	29789	65353	31330
240	28994	29789	65353	31330
241	28994	29789	65353	31330
242	19718	20336	40028	20929
92	28960	29739	68139	31199
247	29386	30154	51342	30613
249	32900	33019	59978	35564
20	28962	29077	52763	31300
276	18611	18898	43949	20582
277	18611	18898	43949	20582
72	19687	20417	22726	21526
71	19687	20417	22726	21526
280	30180	30739	63887	32016
282	29700	30342	60106	31279
283	23595	24202	40258	25210
285	23595	24202	40258	25210
65	19752	20407	26856	21318
291	21821	22364	51923	23796
295	24739	25153	60252	26864
298	36789	38621	48647	36272
301	31530	32584	60315	32023
303	12035	12236	25069	13215
305	36016	37571	48898	35692
306	28391	30085	33426	28017
308	23613	24460	23655	23941
310	27159	28335	27036	27042
312	18279	18813	33192	19095
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
315	13651	14108	21208	14006
316	28960	29739	68139	31199
317	22453	22847	64558	24771
318	26744	27535	63442	28201
320	15207	15457	31386	16715
118	25811	26570	55690	27469

Table 10-6. Seasonal food resources without bison/ calculated for selected site catchments at Fort Sill. Figures are in thousands of calories.

SITE	SPRING	SEASON SUMMER	FALL	WINTER
Cm- 233	11700	11819	38778	11700
69	6175	6870	10933	6153
68	6175	6870	10933	6153
67	6175	6870	10933	6153
234	7105	7590	25763	7043
235	8368	9127	38247	8424
58	8707	9092	24857	8643
236	7105	7590	25763	7043
74	7767	8799	23489	7713
239	7908	8416	31249	7946
93	10919	11715	47279	10919
240	10919	11715	47279	10919
241	10919	11715	47279	10919
242	6294	6912	26604	6331
92	10620	11399	49799	10618
247	8174	8942	30130	8101
249	11700	11819	38778	11700
20	10281	10397	34082	10281
276	8105	8392	33444	8105
277	8105	8392	33444	8105
72	8427	9157	11466	8406
71	8427	9157	11466	8406
280	9457	10016	43163	9455
282	8750	9392	39156	8749
283	8321	8928	24984	8258
285	8321	8928	24984	8258
65	7646	8301	14751	7610
291	8779	9322	38881	8776
295	9393	9807	44906	9393
298	4716	6547	16574	4739
301	6280	7335	35065	6280
303	5200	5400	18233	5158
305	5210	6765	18091	5165
306	3844	5538	8879	3826
308	4646	5493	4688	4646
310	4129	5305	4006	4129
312	5270	5804	20184	5227
313	5270	5804	20184	5227
315	3242	3699	10799	3217
316	10620	11399	49799	10618
317	9664	10058	51769	9664
318	8130	8921	44828	8130
320	6601	6851	22780	6555
118	8368	9127	38247	8424

Table 10-4. Weight and caloric values used for estimation of plant food resource potential for site catchments at Fort Sill.

PLANT FOOD GROUP	Usable Weight/plant (kg)	Calories/kg	Calories/plant
Nuts	4.28	5348	22,889
Fruits	0.016	565	9
Roots	0.141	658	92

Protein and basic notrients can be calculated for each resource group. These factors would permit better evaluations of the actual carrying capacities of the catchments.

Chapter 11

CULTURAL RESOURCE MANAGEMENT AT FORT SILL: BACKGROUND AND PERSPECTIVE

by
D. Kevin Leehan and Steven A. Hackenberger

complete as possible environmental data were emphasized. Notes from these explorations contain observations in regard to geography, geology, botany, zoology, ethnology, meteorology, soil science and in some cases even archaeology (long before the field viably existed

Army, did much to save the Fort's buildings from being abandoned by improving their maintenance (de Shazo, 1957:5). The second move can be more clearly seen as the result of concerns for the historical significance of the Fort's buildings. This move came in [illegible] original buildings were

Both the Antiquities Act of 1906, the Historic Sites Act as well as the 1936 Park, Parkway, and Recreational Area Study Act laid the legal foundation which was sufficient to form the River Basin Survey Office of the Smithsonian Institution in 1945. This endeavor marked the beginning of a twenty-five year period of federally funded salvage archaeology in this country.

The Park, Parkway and Recreational Area Study Act authorized the National Park Service to assist other Federal agencies in the compilation of data on recreational needs in projects under development by the Army Corps of Engineers and the Bureau of Reclamation. Included under the study of recreational needs were "examining artifacts, and inspecting archaeological features" (Kahlen, 1947:216), thus archaeological surveys were first included under recreational studies.

In 1945 concerned archaeologists formed the Committee for the Recovery of Archaeological Remains in response to Federal plans for the placing of numerous dams in the major river basins of several sections of the U.S. Working with the Federal agencies involved in the projects this committee provided the technical assistance for what became the Inter-Agency Archaeological Salvage Program. Such cooperative efforts served as an extension and refinement of the original inter-agency agreements. Fiscal and administrative tasks were placed with the National Park Service, while the Smithsonian acted as a coordinator (as well as an implementor) of archaeological work. Later in 1960 another major piece of legislation was passed, the Reservoir Salvage Act. This law provided for advance notice of dam construction and ancillary activities to be given to the Secretary of the Interior, and that if it was necessary survey and subsequent salvage work would be carried out. Most importantly this act also provided avenues for funding the work necessary to carry out the provisions of the Act.

Through all of the above legislation concerning reservoir construction, massive amounts of archaeology were accomplished in some reservoir construction areas on the Great Plains. Some archaeological surveys were accomplished in Southwestern Oklahoma during this period. Among these were early incomplete surveys of the Salt Fork, Elm Fork, and North Fork of the Red River (Wenner, 1947); a fairly extensive survey of one portion of the Salt Fork, done in connection with the proposed construction of the Mangum Reservoir in Greer and Harmon counties (Wyckoff, 1963); a survey of water retarding structures on El

Although some testing was completed in the Mangum Reservoir (Leonhardy, 1966b), little mitigation resulted from the survey work listed above.

One of the most disappointing records of work during this period concerns one of the potentially greatest areas for mitigative archaeological work to have taken place. This record regards the construction of Lake Texoma at the junction of Red River and Washita River by the Corps of Engineers. Archaeological Work in the reservoir area was begun in 1942 by the University of Oklahoma, but continued only sporadically, and for the most part without any funding from the Corps or the National Park Service over the next twenty or so years (Prewitt and Lawson, 1972).

In general, lack of investigation, although sometimes due to project abandonments, has been disappointing in terms of the progress in cultural resource management, or investigative exploitation in this area, in comparison to other portions of the Great Plains. These disappointments can often be attributed to lack of responsibility on the part of both archaeologists and Federal agencies which were ultimately responsible for work in the region during this period.

During this period, Fort Sill, of course, had little to do with large scale development of water resources. However, the general concern for archaeological surveys of such Federally controlled properties led, in a round-about way, to an archaeological survey of Fort Sill's reservation (Shaeffer, 1966a & b; 1961). This survey was the result of desires of the staff of the Fort Sill Artillery and Missile Center Museum, under the direction of Mr. Gillette Griswold. The stated purposes of this survey was to help fill in a geographic gap in archaeological knowledge which existed between project related surveys in the western portion of the region and the Lake Texoma area. With this purpose the survey became the first active expression of a concern for prehistoric cultural resources on the Fort's reservation. This survey later led to some testing of six prehistoric sites (Shaeffer, 1961).

Still, however, this survey was not accomplished for purposes of cultural resource management. This fact is most apparent in the reports lack of outlaying serious means through which mitigation or preservation could be achieved at important archaeological sites. Undoubtedly this fault was due to the origins of the project with a group, which although concerned, did not hold the responsibility for disturbing cultural resources on the post. Not only was this the situation with regards to the Fort's Museum, but at this time no agency or department of the Fort was legally responsible for mitigation of impacts incurred by cultural resources.

Until the year in which the Fort was first surveyed for prehistoric cultural resources, all major legislation which would have directly applied to the preservation of these resources only regarded the construction of reservoir area and not to other major governmental activities which potentially disturb cultural resources.

In 1966 the National Historic Preservation Act was passed by Congress, and was responsible for establishing the National Register

of this act has been the establishment of environmental impact statements as standardized procedures in government actions.

Executive Order 11593, signed into act in 1974, states concern for the protection and enhancement of the cultural environment and calls for detailed inventory of all federal properties for sites which can and should be nominated to the National Register. What is

"cultural resources" contains a summarization of the Fort's entertainment facilities, and completely ignores the issues pertinent to proper cultural resource assessment. The second of these assessments includes only a brief but more appropriate statement of cultural resources and the potential impacts One Station Training was expected to have on cultural resources. This statement, which concluded that no site of historical or archaeological significance would be disturbed, has proven inaccurate.

As was mentioned earlier, it is also the purpose of this section to trace the development of the actual concept of resource management and review its practice on Fort Sill and in Southwest Oklahoma as a whole.

The actual development and practice of principles of cultural resource management, as opposed to exploitive mitigation, has crystalized only recently, and is a general response to increased environmental impact assessments, although such concepts have floated about in American archaeology for some time. The most clear statements regarding these principles have been provided by Lipe (1974). Basically the crystalization of those principles represents a response to the fact that data collection in archaeology involves inherent losses of archaeological information pertaining to sites, especially when given the frequent, less desirable circumstances under which sites are dug.

Previously, land alteration projects have been considered to have priority over the conservation of any existing resource in an area to be disturbed, thus cultural resource management consisted of recovering as much data about the resource as was possible. Presently, however, the destruction of cultural resources is not the only option considered. Cultural resource managers have increasingly become involved in planning stages of land alteration projects, and have increasingly alleviated the use of mitigative work through "spatial scheduling" of potentially destructive activities (i.e. avoidance of sites). Fort Sill, in that it represents an ongoing installation with continous and somewhat flexible activities, offers such potentials for management alternatives.

The most recent legislations have had a profound affect on archaeology now being accomplished in Southwestern Oklahoma. While only one major reservoir project is being completed in the region (the Waurika Reservoir in Jefferson and Stephens counties) numerous smaller, Soil Conservation Service and Highway projects have been completed throughout the region. Additionally three lake shore studies have been accomplished,

one of Altus Lake (Burton and Burton, 1970) and two restudies of Lake Texoma (Prewitt and Lawson, 1972; Good, n.d.). However, no actions have been taken for cultural resource management by either of the two seperate Federal agencies involved with the reservoirs. Still, too few management alternatives seem to be in the works for these resources.

Chapter 12

LAND USES AT FT. SILL: AN ASSESSMENT OF POTENTIAL IMPACTS ON CULTURAL RESOURCES

by
Daniel Crouch and D. Kevin Leehan

Introduction

The following section will describe land use activities as they relate to potential impacts on cultural resources located at Ft. Sill. The primary purpose of the discussion is to define the various activities, their spatial dimensions and the physical relationship of the land use to potential cultural resources, as each of these factors bears on the problem of cultural resources management at Ft. Sill. It is not the purpose of this discussion to assess the impact of any given activity on a specific site, but rather to assess the overall potential of the activities to affect sites should the activity and a site co-occur spatially.

Obviously land use activities form only one aspect of the total potential impacts on cultural resources at Ft. Sill. The current investigations as well as other past and present efforts towards preservation of cultural resources can themselves be considered significant and beneficial impacts which must be considered part of a total impact evaluation. However, land uses which disturb the earth's surface are, in general, not likely to have a beneficial impact on an archaeological site. It is the objective of cultural resource management to minimize adverse impacts, and not necessarily to terminate land use. The purpose of this section, then, is not simply to identify land use activities as deleterious impacts, but rather to perform the first step towards their evaluation as potential impacts. Ultimate evaluations involve more complex considerations, including the severity of the potential impact, the alternatives to either the activity or its location, as well as the significance of the resource which may be involved. These aspects of impact evaluations will be taken up later in the report.

The complexity of land use activities at Ft. Sill is proportionate to the scope of those activities. Ft. Sill is, at once, a home for thousands of people with needs ranging from housing to recreation, the location of a broad range of training operations which change as

military science and technology change, and also a massive land area, with significant natural resources which must be protected and enhanced for the use of all. At every turn, daily life at Ft. Sill must

of Fort Sill. This assessment is necessarily subjective, based on amount of subsurface disturbance with a view to the types of information and of sites which might be adversely affected by the activity. Although subjective, these scalings are based on months of field observations made during the course of this survey both of the activities themselves and of sites impacted by them. In the discussion of training activities, impacts are scaled in terms of "low," "medium," and "high" levels of potential impact. In the non-training section, impacts are scaled in increasing intensity (or potential) by "level 1" through "level 5" rankings.

The loci of past human activity which are the concern of cultural resource managers can be divided roughly into extant building sites and archaeological sites. The primary focus of impact assessments is the latter, which are being damaged and destroyed at a fast and alarming rate nationwide.

There are two avenues of information retrieval with regard to an "archaeological site." These are the tangible and the intangible. The former refers to the physical artifacts of cultural activity, those things which can be collected and returned to a laboratory for study. Because of their display potential and because of the trouble necessary to recover them, these too often receive paramount attention. Actual loss of artifactual materials is usually a selective process, with bones and other organic materials being lost first. Of far greater importance and potential are those intangibles which are destroyed as a site is disturbed. These are factors which carry with them meaning which must be correctly assessed and collected in the field or are lost forever. In general, these factors can be divided into two groups: those which deal with archaeological context and those which deal with environmental context. The former refers to the in situ positioning of one artifact relative to another and of the artifacts to certain remains which cannot be removed for study, such as fire pits, postholes or other features having cultural significance. "Environmental context" refers to the relationship of sites of human activity one to another and to the relationship of those sites to their ecological and natural surroundings. As will be amply shown in the following pages of this report, these factors of context are of far more potential than artifacts themselves. It is only appropriate, therefore, that damage of these intangibles be considered as of at least as great and probably greater significance than the loss of simple artifacts.

In making an assessment of the level of potential impact incurred from a particular activity, consideration was made of the type of damage, whether it would destroy artifacts or their context. Certain

types of sites have been totally exposed by natural agents. Such sites may be damaged by even vehicle traffic, for example, because such traffic 1) would result in damage to the exposed artifacts, and 2) would

Training Activities

Introduction

In the following discussion of training activities, use has been made of the activity areas land use reporting system. This system distinguishes firing and non-firing subdivisions within training activities and provides the refinement and enumeration of areal use across the reservation which allows comparison with locales of varying predicted site densities. Therefore, the concept of these activity areas will be introduced and defined with a statement of problems encountered with use of the system. Each of the subdivisions, firing and non-firing respectively, will then be defined, described as to reported use areas, and assessed as to the potential impact of specific activities upon cultural resources.

Definition of Activity Areas

The activity areas concept and map are constructs of USAFACFS, originated by personnel in the Directorate of Facilities and Engineering. It was done several years ago in response to a General Services Administration requirement that Ft. Sill justify the retention of its large land holdings. The 144 activity areas, ranging in size from 10,479.35 to 35.22 acres, were laid out across the military reservation and daily reports of their use have since been made through the Range Office. Information is obtained as to the unit, activity, area assigned, number of people involved, and the hours utilized. These records are collated at the end of the year and the man-days per activity area group computed.

The year 1976 was selected for study because is is the largest complete use year recorded to date and includes within it certain recently acquired responsibilities, such as One Station Training, which would affect the results. A further consideration raised by the Range Office is that while presumably mandatory, reporting of usage has been improving since initiation of the scheme, but is not yet 100%. Inadequacies are therefore inherent but probably smallest in 1976.

The activity areas as laid out often follow unnatural features such as modern roads (Figure 12-1). Such criteria being unrelated to topographic, geologic, biologic, and other criteria useful to considerations of cultural resource location required a joint quadrat/activity area approach to areal impact scaling.

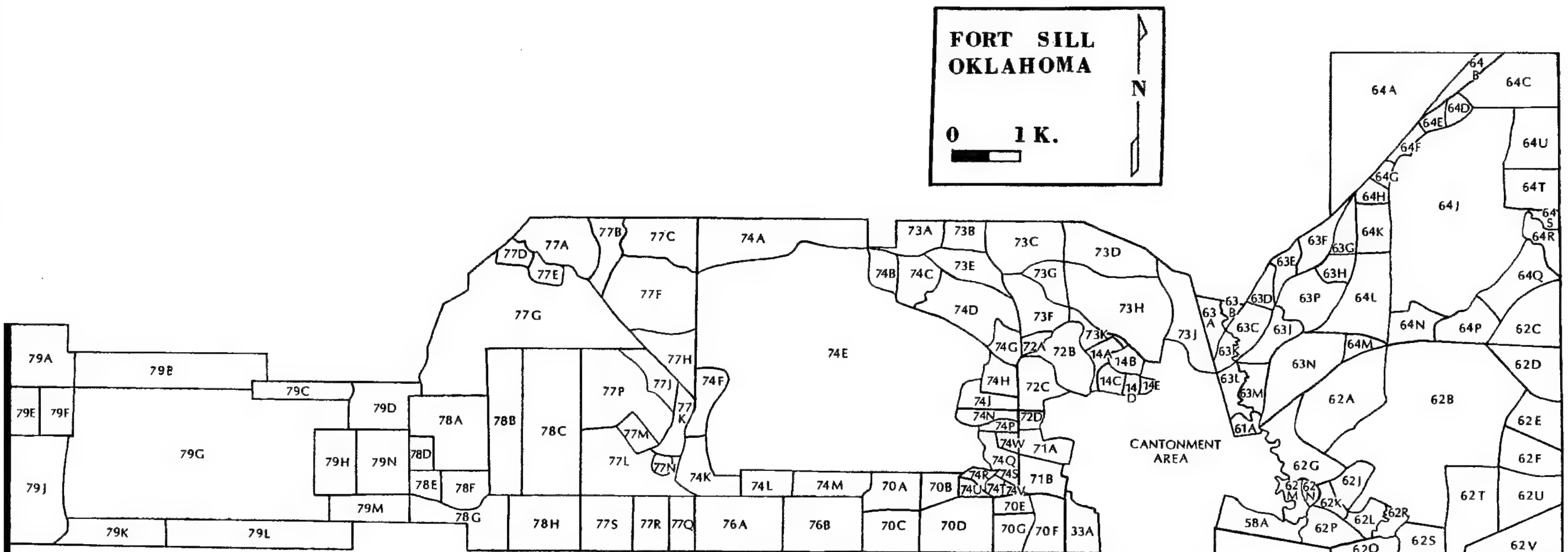


Figure 12-1. Map of training activity areas at Fort Sill.

In making its report to GSA, USAFACFS compiles groups of activity areas, i.e., the 14 series, the 62 series, the 63 series, etc., rather than single areas themselves. This approach required the authors to go to the original daily reports, kindly supplied by the Range Office, and to begin anew to compile on this latter basis. The time required by this procedure forced us to draw a sample from 1976 rather than to use the entire year. In addition to the difficulty in this recompilation was the further problem with the firing activities of determining the area being used as the firing point. Overflight and impact areas are listed with no distinction from the firing area because all are compiled by the Army as having had equal usage. However, for purposes of consideration of cultural resources management, this would effectively blur individual area's true usages. Thus the extra time needed to determine which area served for the [illegible]

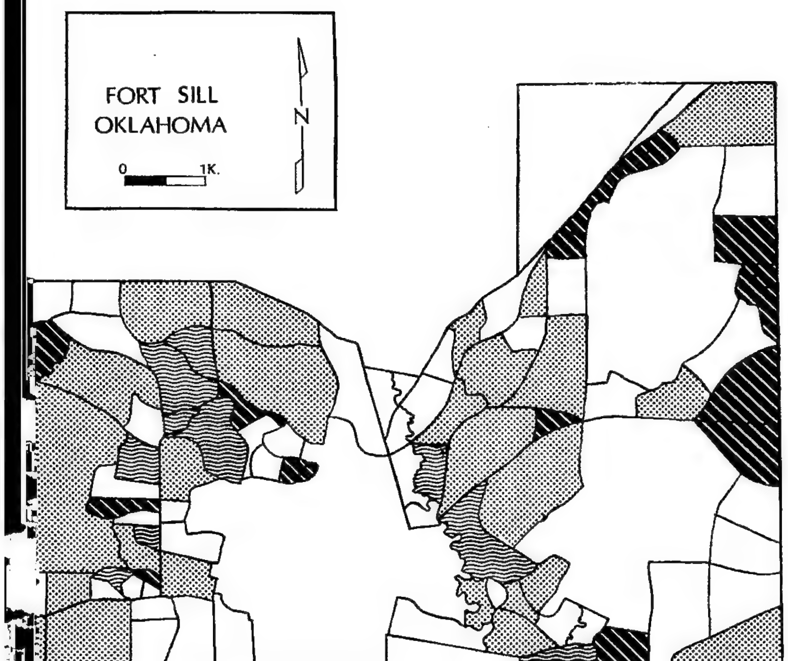
Firing Activities

An area is considered to have high use when the sample months indicated three or more reported man-days per acre. Eighteen areas, all in the eastern half of the reservation, show such high use (Figure 12-2). Most of these, including 14D and 14E, and those fringing the North Arbuckle Range, can be related to established instruction areas. The range of moderate use is from one to less than three man-days per acre. Eleven areas of moderate usage are present as are 54 of low usage with less than one man-day per acre. Areas for which no usage was reported during the sample months have been left blank.

In brief summary, most high usage is related to repeated use of specific and established training areas. Otherwise, most severe general use is in the area between the Cantonment and the West Range with additional use of the Cache Creek floodplain and environs on the East Range. This appears to be very similar to the non-firing pattern in that usage is made of Cache Creek and Medicine Creek areas but also with additional usage of firing points on the eastern portion of West Range. The tendency to heavily utilize those areas closest to the Cantonment is shown in both.

The potential impacts in an area should not be considered to be insignificant merely because it is shown to have a low firing activities usage rate. The many low use areas in the western half of the reservation represent almost entirely the many firing points from which the West and the Quanah ranges are bombarded. The determination that use was low for these areas was made on the basis of usage <u>per acre</u> of area, yet almost the entire sum of that usage took place within a 200 m radius of a limited number of firing points within each of those areas. Thus while usage for the entire area might be low, the potential impact of that usage is great because of its concentration. It is cogent, therefore, to make certain recommendations specifically to the management of firing positions in the following discussion of firing activity impact assessment.

A type of firing point which must be dealt with separately because of its unusual nature is the so-called "floating" firing point. These are grid co-ordinates requested by a unit and approved by the Range Office for one-time use as a temporary firing point. The one-time use of these "floating" firing poihts might seem to qualify it for only a moderate level of maximum potential impact. However, their damage is more nefarious because although less, it is an area which might have otherwise been pristine. They must then be assessed as having a high level of impact.



activities at Fort Sill.

The only other remaining firing activity which needs to be discussed is that which uses established and constructed ranges. These are widely spread over the Post and vary in design and subsequently in assessed potential impact. Factors which must obviously be considered in the designing of such facilities are the type of weapon being fired and the number of people being instructed. It is impossible here, as with other types of constructions, to accurately assess them all. However, as a group, such constructions must be considered as of high potential adverse impact due to the earth-moving generally required for firing stations and/or backstops. Surveys of all potential or designated sites for new construction should be carried out when appropriate.

Non-Firing Activities

The results of the three month sample of non-firing activities are shown in Figure 12-3. All of the 17 high use areas had 40 or more man-hours usage per acre reported during the three month sample. Twenty-six "moderate" areas are shown with from ten to less than forty man-hours per acre use during the sample. The remaining 53 areas of low usage have less than ten man-hours per acre while areas with no reported usage for the sample months are left blank.

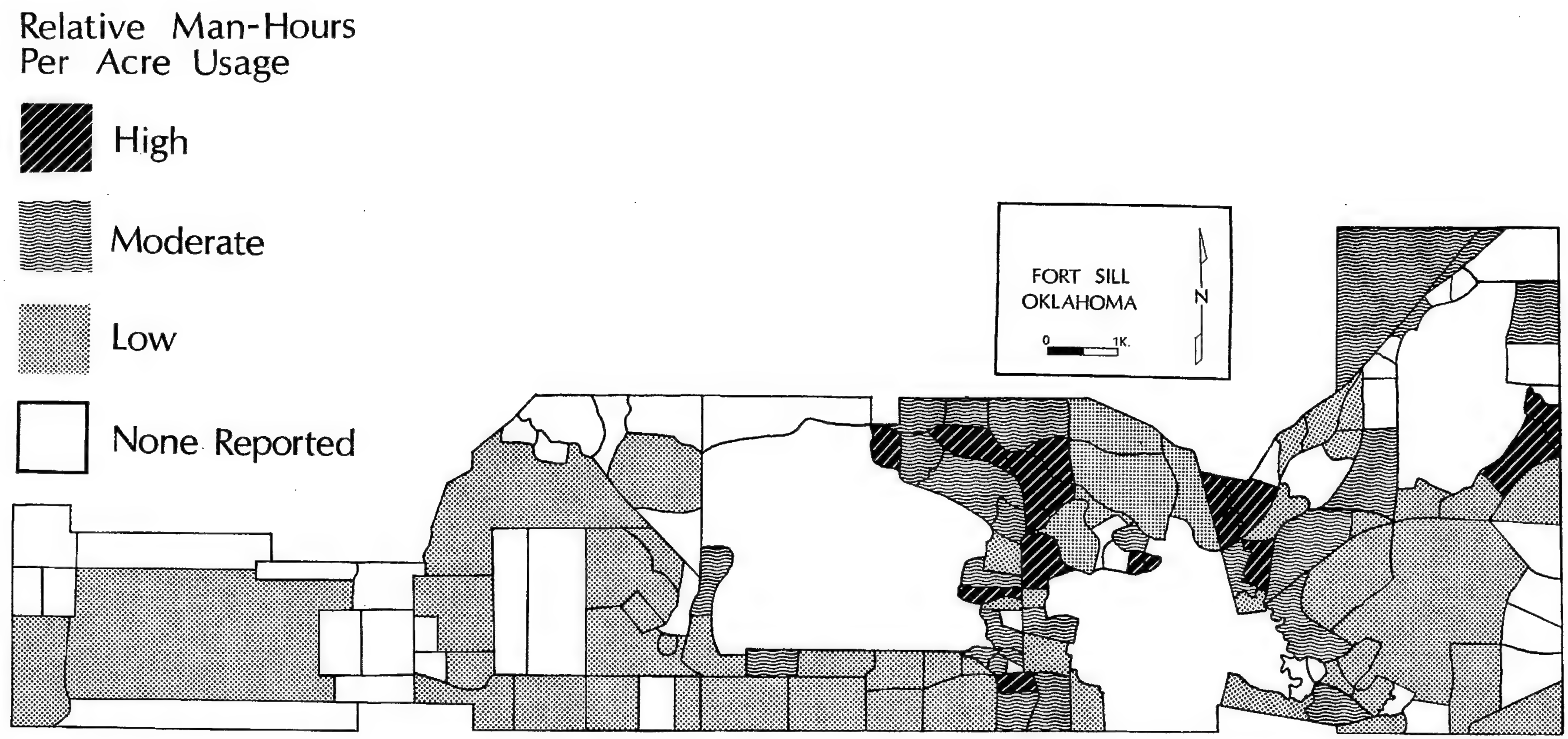


Figure 12-3. Map of scaled intensities of non-firing activities at Fort Sill.

It is noteworthy that two areas, 14D and 14E, which receive high use contain the National Historic Site of Medicine Bluffs. The specific

these activities can be greatly lessened. Since little can be done to alter the Army's need to conduct such operations, these recommendations are aimed at 1) lessening the extensiveness of the damage and 2) limiting the likelihood of the impact upon a site. The extensive distribution of these disturbed areas is likely due to the disturbed condition of previously used areas. It would limit the potential damage, therefore, to establish reserved areas for these types of operations. The selection of areas for such activities could be made in a consultation with archaeologists, using results of this survey and/or additional survey for the selection of locales where predicted adverse impacts are minimized. Areas could be assigned through the Range Office to requesting units. If these areas could be kept as pristine as possible and occasionally allowed to return to their "natural" condition, a "recycling" could be effected, benefitting not only the archaeology of the reservation but also the ecology.

No doubt the most damaging of the many firing activities is the actual shell impact itself (Figure 12-4a,c). While perhaps not physically so, such areal utilization must at present be considered as totally destructive because 1) the destruction of artifacts as well as of their context through cratering and because 2) it effectively places those cultural resources within the impact area out of reach of possible study (Figure 12-4,6).

The primary effect of firing activities, however, is upon the many types of firing points in use. These must also be considered as of high potential maximum deleterious effect upon cultural resources but most certainly vary in their impact within that high level. For example, the most severe use which a firing point can receive is as an entrenched firing point, that is, one at which the artillery pieces fire from deeply excavated pits (Figure 12-4,d). All firing points generally, however, have been assessed as of high impact because of the repeated manner in which they are used (Figure 12-5,a). Vehicle traffic, and particularly tracked vehicle traffic, is very destructive to surface sites and can also have disastrous effects at a deeper level (Figure 12-5b). Subsurface disturbance also results from the excavation of "spade holes" for the laying of a towed field piece and from the seating of the rear spade on a self-propelled field piece. Where units are repeatedly assigned to carry out such operations within a 200 m. radius area, damage accures more or less quickly depending only on the frequency of use.


Permanent Constructions

Unlike the other activities discussed here, "permanent constructions" includes all buildings on the reservation with a foundation and/or a non-earthen floor. It also includes training constructions such as firing ranges, all of the One Station Training instruction courses, etc. most of which are outside of the Cantonment area. In the case of buildings, the processes of landscaping, laying a foundation, supplying plumbing, electricity, etc. are easy to catalog and assess. Instructional areas are not so easy to classify as assessment would vary depending on the design of the particular construction. Rather than assess each construction design now in use, all will be treated as a group. Because of these destructive influences and because of the unavailability of the site to future research, buildings should be considered as of level 5 impact. Instructional constructions should be considered as of level 4 impact. The difference in these reflects the relatively less severe damage done by a few of the latter. Thus, survey, testing, and possible mitigation of affected sites should be carried out for both types of permanent construction.

While sites scheduled for new permanent constructions should be considered as of level 4 or 5 effect, that is not to say that known sites already affected by a permanent construction are to be considered as totally destroyed. Particularly where the significance of a site is known to be high, the site area should be treated as though remnants of the site did exist until such time as extensive testing revealed total destruction or closely delineated the parameters of the extant site.

Subsurface Pipelines

While a necessity to the continued functioning of an active and growing military post, the emplacement of underground cables, pipes, etc. carries by its very nature one of the most severe impacts which can be sustained by a site. Several sites included in this survey report show impacts from this source. The areas of primary impact include the entire trench excavation and to an extent the ground surface around it which bears the increased earth-moving equipment traffic. Secondary impact in adjoining areas may be incurred as a result of increased erosion.

Survey of the entire route prior to emplacement of a subsurface line is the only adequate way in which to locate affected sites. Where the cultural resources have been considered in the planning stage the line may be rerouted around discovered sites. Otherwise, mitigation

may be necessary. Special attention should be paid to portions of pipelines which pass near the Cantonment, National Register sites, and known archaeological sites. Where renewal or expansion of an existing line is to be carried out, survey is not necessary only so long as the reexcavation does not expand upon the limits of the original trench. However, where such projects are planned through known sites, the appropriate individuals should be notified so that an examination can be made of the artifactual material being recovered and of the site profile being revealed.

Projects entailing major subsurface disturbance can disturb sites which may lay buried and undetected even by the standard survey and testing procedures. Therefore, the proper agency should monitor all projects of this sort, including reexcavation of an existing line, and carry out on-the-spot evaluation. Where the potential importance of the site is such that further treatment is warranted, the project should be halted until alternatives are assessed.

Firebreaks

The purpose of firebreaks is to limit the extent of the frequent grass fires in the range areas and to keep them from going off of the reservation. In addition, they can also serve as secondary roads. These are at least 30 feet wide and are created by road graders or bulldozers which scrape the vegetation off at least to root depth and push the debris into long rows along the breaks. By this piling technique not only is the buried vegetation killed but the earth removed can be redistributed over the firebreak during the next maintenance period. The latter process inhibits the incision of the break into the

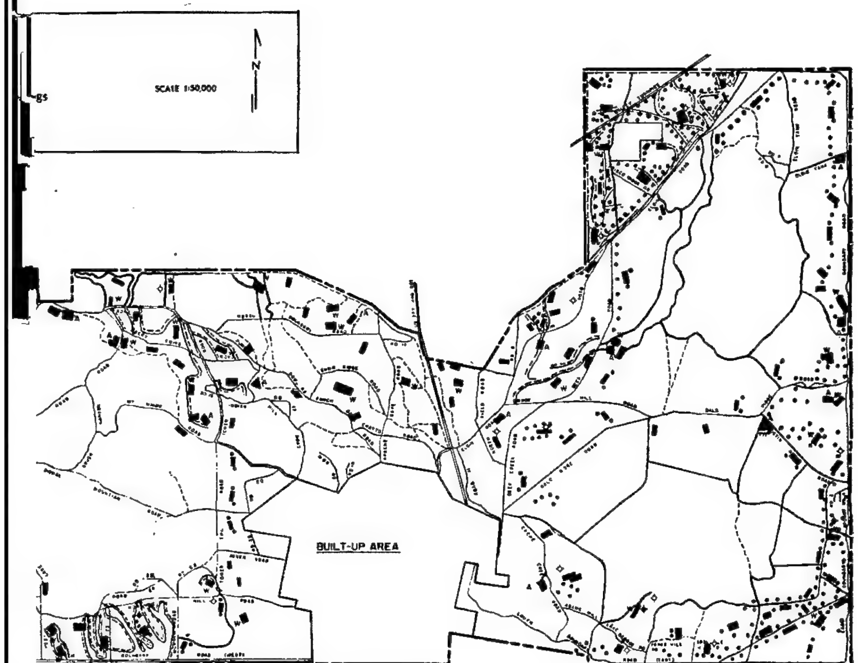
All firebreaks will be cut three times a year. The lessee will be notified in writing and will commence work within 10 days after receiving the notice to proceed.
All firebreaks on this lease are established firebreaks which have been cut an average of twice a year in the past.

At present, DFAE is experimenting with the timing and frequency of maintenance so changes may be expected in the near future.

The Director of DFAE and the Chief-Fire Prevention and Protection Division, DFAE decide, based on staff recommendations, where firebreaks will be located (Figure 12-6). Adjustments are permissible in the field according to the individual situation, however. In determining where new breaks will be located, a number of factors are considered. Army policy, for example, dictates that breaks must follow the perimeter of the reservation so as to protect the Wichita Mountains Wildlife Refuge and the surrounding civilian areas. In addition, general guidelines are recommended in the Conservation Plan (U.S. SCS, 1970: 71). The intent of these are to minimize the amount of new, radical erosion caused by the breaks. Thus a longer route might be taken if by doing so the new break would avoid very steep slopes. Of course, prior use of a position for military purposes is also a consideration.

Not all firebreaks are denuded of vegetation. The planting of "cool season grasses," as discussed in the Conservation Plan (U.S. SCS, 1970: 72), has been successfully applied to certain breaks. Cool season grasses are an effective anti-fire measure during the winter because the green grass is less likely to burn. However, these "green breaks" must be bladed free of vegetation in June when the grasses turn brown and must be disced in late August or September to permit germination of the new seed. The advantage of this approach is that it partially avoids the damaging erosion caused by bare earth breaks. Even though these plants are annuals they can and do tend to return the next year. Their application, however, is and will probably continue to be limited because of the expense entailed in establishing these annual grasses in the firebreak.

The creation of firebreaks and subsequent erosion and maintenance are potentially damaging to sites. The impact must always be considered as of level 4. This impact is not only on the width of the break but also for an increasing distance out from its margins where erosion may occur. The degenerative effects of firebreaks go on in



vildlife plantings.

spite of such antierosion measures as cool season plantings and redistribution of piled earth. New routes should be carefully surveyed beforehand and note taken of areas of high predicted site density. Old breaks should be rerouted where they damage important sites.

Hard-Surfaced Roads

Care for the hard-surfaced roads on the reservation is the responsibility of the Roads and Railroad Branch of the Buildings and Grounds Division of DFAE. Because of its limited size, however, it does only minor repair and maintenance. New road constructions are let out on contract to the civilian sector.

Responsibility for funding and for design and layout of new roads cannot be easily ascribed. Funding of projects depends to some extent on the size of the appropriation necessary for its completion. While small projects may be alloted for at a lower level, large projects are subject to appropriation directly from Congress. Fort Sill itself has little control over funding other than the option of initiating a request.

Design and layout control of new roads is equally complicated. A study is now under way of the existing road network on Post. With its results and the present building plans, a long range plan of hard-surfaced road construction will be developed. This is done by the Engineering Division of DFAE. However, once the long-range local goals are determined and a working design based on these goals established by them, the plan must be submitted to higher authorities, including the Corps of Engineers, so that it may fit into their future plans both for Fort Sill and for the other installations under their control. The compromise plan will then be worked out by the many interested parties. There is thus no single "final authority."

Hard-surfaced roads must be considered as of level 5 impact for two reasons. Foremost is the actual destruction that is imparted to a site across which such a road runs. Grading and landscaping are direct impacts in this regard while the inevitable off-road traffic and erosion have secondary effects. For these latter reasons, the area of impact of a road lies not just in the roadbed or in the right of way

While there is no "final authority" concerning the planning or funding of new hard-surfaced roads, the most efficient level at which cultural resource management considerations might have input into the planning of such schemes as the new road or permanent buildings layout is early in planning and at a local level. This appears to be with the Engineering Division of DFAE to whom information concerning the potential bearing on sites of long-range plans should be made available.

Range Ponds

Two categories of range pond exist. These are the "floodwater retarding and multipurpose structure" and "ponds and lakes and low water dams" (U.S. SCS, 1970: 110 and 78). The distinction is primarily based on intended use which in turn affects placement, construction, etc.

The low water dams are intended primarily for the use of waterfowl as shallow, clear waters allow maximum growth of food plants attractive to them (U.S. SCS, 1970: 82-85). Ponds and lakes are intended more for fish management with recreational capabilities as well and as such also have potential shoreline development (U.S. SCS, 1970: 78, 82).

Floodwater retarding dams are deeper and of greater surface size than the lakes and ponds. These are intended to limit siltation and to limit runoff and thus downstream flooding. These also have the potential of recreational development which may be quite extensive including boat docks, parking lots, picnic tables, playgrounds, grills, etc. (U.S. SCS, 1970: 110-111).

Six floodwater retarding structures are planned (U.S. SCS, 1970: 110) and schematic drawings shown in the (U.S. SCS, 1970: 113-118). A great many more ponds, lakes and low water dams are to be constructed or rebuilt. These are shown in Table 9 of the Conservation Plan. A variety of sources contribute to the planning of these constructions but priority is established in the Wildlife Branch of DFAE. Some construction is funded by DFAE while the rest is done by hay lessees as a part of their lease agreement. Funded constructions can be done in-house although none have been built in recent years. The latter are done either by the lessee or contracted bout by him. The SCS office in Lawton, Oklahoma, monitors all construction to insure that it conforms to specifications. The finished construction must also be approved by the Land Management Branch, DFAE.

In spite of the many differences in these types of range ponds, all have a level 5 potential effect on sites. This arises from the earth-moving required to build the retaining dam and the downstream appurtenances as well as the possibly equally destructive impact of recreational development associated with certain of these types. Secondary impacts accrue from the heavy equipment traffic in the general area, from wave action and erosion at the water's edge, from earth borrowing at possibly distant locations, and from the subsequent unavailability of intact sites beneath the dam or waters. Surface survey is therefore necessary for any range pond construction, rebuilding, expansion on or development of recreational facilities, and for borrowing activities associated with the construction. Borrow sites should as a matter of routine be surveyed with the project for which they are utilized. As a final recommendation, therefore, where a site is known to be within 500 m. of such a construction but not to be damaged by it, the perimeter of the work area should be clearly flagged so that workmen will be sure not to stray onto the site itself. A report on the survey of a number of such facilities is included in this document.

Wildlife Plantings

"The primary purpose of wildlife management on Fort Sill is to improve the total wildlife habitat in order to increase the amount of game which can be harvested as a recreational activity. This is accomplished through an intensive habitat improvement and well regulated hunting and fishing program." (NRCR. n.d.:13) not all of these necessarily

Ultimate control and responsibility for the wildlife management program on the Reservation is held by the Director of DFAE. Within this program there are two areal distinctions. The "Designated Wildlife Area" is broad in extent and is open to hay lessees and to military operations. The "Wildlife Planting" is more limited in extent and is applied to the plantings described herein. These latter are off limits to any military or civilian traffic.

Warm and Cool Season Plantings

Both warm and cool season plantings are intended to supplement natural food resources available on the Reservation for wildlife. "Warm season" refers to plants which grow best during the warm months of the year while the opposite holds true for the "cool season" types. At Fort Sill the latter includes only alfalfa and wheat.

Cool season plantings are those which provide not necessarily vital but at least potentially useful food and concentrate game during the hunting season. These are laid out in block plantings of one to four acres extent. The Conservation Plan recommends planting of annuals in plots in a five year cycle. Present practice, however, is to replant a half of each cool season planting each year while simply leaving the other half in its present state to fallow. At the present time there are too many cool season plantings (Figure 12-7). Some will be abandoned in the future. In addition, some have been placed in the past on less favorable soils and will be relocated.

Warm season plantings have, until 1976, only been in the form of strip plantings. "These strips are planted in April and May to provide supplemental food, nesting sites, bugging and dusting areas (Natural Resources Conservation Report, n.d.: 14). A new and alternate planting technique is the block planting of warm season plants (Figure 12-7). It entails soil preparation and planting of milo or millet in ten or 20 acre plots. A firebreak is plowed or disced around the field as it is around other plantings. After the addition of the 1976 block plantings, there is no foreseeable change in the location or technique of warm season plantings.

Criteria for the location of warm and cool season plantings are the same. The Conservation Plan (U.S. SCS, 1970: 97) suggests placement according to "soils, slopes, and need for habitat improvement." It further recommends that plantings only be made on slopes of no more than three percent and on the following suitable soils: Foard silt loam, Foard-slickspot complex, Foard and Tillman, Hollister silt loam, Lawton loam,

Port clay loam, Tillman clay loam, Port loam, Zaneis-slickspot complex, and Zaneis loam. An additional consideration is the species intended to benefit from the planting. For example, those intended for waterfowl might be near ponds where birds such as ducks are more likely to utilize them.

Live Cover Plantings

Live cover plantings are intended to provide some food as well as cover. Like warm and cool season plantings it is entirely mechanized and is intended to produce tree and woody shrub plots. The 1/4 acre plot selected is plowed to a six inch depth, disced and then harrowed. The saplings are then spaced in the furrows with a mechanical seedling planter. A ten foot wide firebreak encloses the planting. Following this the plot is cultivated twice a year for two or three years to keep down grasses that might compete with the saplings.

There are several criteria for the placement of live cover plantings. For the following two reasons they are almost never put into bottomlands:

1) bottomlands generally already have ample suitable cover,
2) competing plants, particularly Johnson grass, move too quickly into disturbed bottomland soils.

Also, the Conservation Plan (p. 170-171) rates soils according to their suitability for woody plantings. The best soils are Konawa loamy fine sand with one to five percent slope, Port clay loam, Port loam, Port-Slickspot complex, and broken alluvial land. Need is also a consideration. At present most of the live cover plantings are on the East Range where a dearth of cover now exists. Once established, these live cover plots should be permanent and require no further maintenance.

Disturbance Plantings

This technique is primarily applied in conjunction with other plantings and is not wide-spread. Basically, it entails the breaking up of land so that so-called "weedy" species which tend to produce more seeds might take it over by natural means. Only the East Range is receiving much disturbance planting. Here it acts as temporary cover

while the live cover plots are being established. The same 1/4 acre blocks are disced each year during the winter to control grasses and encourage weeds.

Concerning disturbance plantings, the Conservation Plan (U.S. SCS, 1970:101) recommends tillage every four years in ten to twelve foot wide strips or blocks on suitable soils. These soils are Foard silt loam, Foard slickspot complex, Foard and Tillman, Hollister silt loam, Lawton loam, Port clay loam, Port loam, Tillman clay loam, Zaneis loam, and Zaneis slickspot complex. These are the same soils recommended for the warm and cool season plantings. In addition, the area should also be open or thinly wooded. (U.S. SCS, 1970: 101).

> Suggested areas are along the south and east side of Quanah Range and along the south side of West Range. Other areas are located along the boundary west of Rabbit Hills and around the perimeter of East Range.

Duck Fields (U.S. SCS, 1970: 98-99)

Goose Pastures (U.S. SCS, 1970: 97)

Two goose pastures are planned for the reservation. These are planned to be 20 to 40 acres in extent, and located in the Quanah Range Table 12 (U.S. SCS, 1970: 234). Neither have been built.

The location and extensiveness of the wildlife plantings makes them an important potential impact. The depth required for cultivation and the turning of the soil represents a potential impact of level 4, requiring that the locations of new, expanded, or relocated wildlife plantings should be examined for sites. Planting sites being currently used appear, based on the 15% sample surveyed in this project, to damage relatively few sites. Relocation of present or planned plantings should be easy as their placement is relatively flexible.

Careful planning of a new planting is useless unless that plan can be conveyed to those preparing it in the field. Usually, careful layout on maps of no grosser scale than 1:25,000 is precise enough to insure proper control. Where archaeological sites are known to be within 500m. of a possible planting, however, the planting borders should first be flagged so that the field operators will not mistakenly infringe on the site area.

Maintenance and Beautification

This description applies only to the 8300 acres of the Cantonment area. While some of these activities are carried on over the entire reservation, these are intended only to correct natural and man-caused erosion. Although "maintenance" in the Cantonment includes erosion control, it is also intended to add to the aesthetic atmosphere. However, while most of the activities discussed under this heading do take place in the Cantonment, those which are conducted elsewhere should be considered as subject to the same recommendations. The Natural Resource Conservation Report (n.d.: 24 and 27) lists these as:

1. Erosion control and drainage projects
2. Leaf removal program
3. Dead tree and stump removal
4. Shade tree planting
5. Tree pruning
6. Grass mowing
7. Litter removal

All of these activities come under the aegis of the Buildings and Grounds Division of the Directorate of Facilities Engineering. Obviously, not all of these will involve great land surface alteration. However, each will be considered separately.

1. Erosion control and drainage projects

According to the NRCR this includes filling of marshy areas followed by reseeding and the grading of slopes. Considered in slope grade is not only erosion control but also difficulty in mowing. As much sod is saved as possible by the use of a sod cutting machine. As described in the NRCR (n.d.: 24), "About 50 acres on sites of 1 acre or less are accomplished each year". The lessening of erosion, as stated already, is an end in accordance with proper cultural resource management. However, the damaging of a site to inhibit erosion is self-defeating. Thus an area to be so treated should first be examined for the presence of a site and to reduce the adverse impact the approach altered if one is found.

There appears to be no conflict between the filling of marshy areas with topsoil and site preservation. However, grading of the "general area" should refer only to grading of the freshly deposited topsoil and not to portions of the site. In grassed areas, a sod cutting machine should be used only if the site horizon has by testing been shown to be well below the maximum depth of the cutter. Otherwise the sod should be left intact, buried if necessary. Where a site is present on or near a slope it should be resectioned only by the dumping of fresh topsoil. The original slope should not be reworked. If discing is necessary following hand reseeding of the slope, the maximum depth of the discs should be set high enough so as only to turn the new topsoil and not the original slope.

2. Leaf removal program

This activity is primarily carried on during November and December. These are for the most part collected mechanically and deposited "within several large wooded sections of the Contonment area" where they are available for future mulching (NRCR, n.d.: 24). A variety of mechanical blowers, vacuums, and pickers are used in the annual pickup.

There seems to be no potential damage to sites from simple leaf collection. However, mulching areas should not be placed near known sites as the increased vehicular traffic could prove destructive. At

present only one mulching site is used on the Reservation. This is located on the east side of East Cache Creek just below Hoyle Bridge. Extensive subsequent modification of the area has already occurred. This is in an area of potential historic significance. Should any expansion of the mulching area or further clearing or earth moving take place, a thorough survey should be undertaken.

3. Dead tree and stump removal

This is a winter job begun in November after maps have been prepared of affected trees in October. About 300 trees and stumps are removed each year. Dead trees are presently cut with hand chain saws and pulled over prior to removal. Stumps are destroyed in place by use of a stump grinder.

The cutting of dead trees does not appear to have any potential adverse impact on sites. Stump removal, on the other hand, has great potential for site disturbance were such techniques as explosives or simple stump pulling used. However, so long as no ground displacement occurs, the use of a stump grinder appears to have no potential adverse impact on cultural resources. Alternate techniques such as deterioration by chemicals might also prove to be advantageous from a cultural resource management standpoint.

4. Shade tree planting

The planting of shade trees is a largely mechanical operation which can accommodate trees of up to 4 inches diameter. About 450 are selected each year in September from the many wooded areas on Post and transplanted through the winter beginning in September

5. Tree pruning

Pruning entails only removal of above ground unwanted portions of trees and shrubs. Most of the 3500 trees pruned annually are treated during fall or winter.

No potential adverse impacts are presented by this activity.

6. Grass mowing

Mowing not only aids the aesthetic appeal of the post, it also acts in the formation of a thick mat of short grasses and in that is in tune with cultural resource management.

No adverse impacts are necessarily entailed by grass mowing.

7. Litter removal

No potential adverse impacts appear to be associated with this activity.

Recreational Facilities

Recreational facilities and activities are or will be under the control of the Recreation Services Division of the Directorate of Personnel and Community Activities (DPCA). The mission of Recreation Services is "to assist the commander in maintaining the morale of Army personnel and their families, and other members of the military community" (USAFACFS Pamphlet 28-4). It is concerned with a wide scope of Post functions many of which have little if any bearing on sites over the reservation as a whole. Those which do have such a potential appear to be subsumed under the Outdoor Recreation Branch of Recreation Services.

Outdoor Recreation

The single most developed site on Ft. Sill under the auspices of Recreation Services in the Lake Elmer Thomas Recreation Area (LETRA). Facilities include fully furnished mobile homes, travel trailer sites with all utilities, a variety of support buildings, picnic tables and barbecue pits, playground equipment, etc. Because of the nature of these

improvements and because of the intensity of use of the area, the impact of this sort of development should be considered as of level 4 and perhaps of level 5. At the present time, no other such facility is planned for the reservation.

Also within the LETRA area but of a different nature are the so-called "primitive campsites." These are located "near the shore in a densely wooded area" (U.S. AFACFS, 1976:8). At present, development includes only some clearance of paths through the undergrowth and the location of trash receptacles and chemical comfort stations nearby. Barbecue pits and picnic tables are also to be added in the near future. With these additions the primitive campsites should be considered as of level 2 impact. Factors which make for such a level relate in part to the intensity of the area's use rather than to the type of activity. Further impact is entailed by vehicular traffic to tend the comfort stations and to remove the trash. In addition, should the barbecue pits and the picnic tables require excavation for concrete emplacement, etc. this too might represent damaging agents on a possible site. Thus it would be advantageous to locate primitive campgrounds away from known site locations. When these campgrounds are being planned or are to be expanded and a previous survey has not been conducted, such a survey should be done where subsurface disturbance is necessary or where use is expected to be unusually high. Should it be necessary to locate a primitive campground on or very near to a known site, adverse impact can be greatly reduced if conveniences such as picnic tables were of a type not requiring excavation. Also while sanitary facilities are encouraged, roads into the area for vehicles to service these should be laid out so as to avoid the site altogether. Users should also be admonished to disturb the local environment as little as possible. This particularly would include digging of such things as tent trenches for water runoff.

In addition to the facilities just discussed are other, less developed functions of Outdoor Recreation. The four large picnic grounds in the Cantonment area are, like the primitive campgrounds, not heavily developed. These are in heavily wooded areas which contain picnic tables, barbecue pits, and playground equipment. In addition, trash barrels and chemical comfort stations are available. Where not near a major road, dirt or graveled roads provide access. The four picnic areas are located on the north side of Medicine Creek just west of White Wolf Bridge, on the north side of Medicine Creek to the east of White Wolf Bridge, on the north side of Medicine Creek directly north of the Old Quadrangle, and between Quinette Road and the H.E. Bailey Turnpike in the McMahon Woods. Such picnic areas should be considered as of level 2 impact where they are largely undeveloped. However,

where water flow sanitary facilities, hard-surfaced roads, large stone barbecue pits, pavilions, etc. are planned, impact is level 4. Should any existing facility be upgraded by such improvements, a survey of the area should be done if appropriate. While under the proper circumstances a modestly developed picnic area can have the effect of helping to preserve cultural resources, gradual development may be as destructive as any other one time building program.

As the responsibilities of the Recreation Services have grown, it has become necessary to provide it with the capabilities to take these on. Consequently, the Outdoor Sportsman's Center was established to

Assuming that the opening of the intended garden plots will entail nothing more than tilling, etc. necessary for soil preparation and planting, it is placed at level 4 impact because it entails the possible disruption of the context of any cultural material present in the area. Should it also be necessary to remove portions of an earlier historic structure, for example, the results could be serious.

A skeet and trap range, should it be built along the lines of that existing at the time of this writing, will have a level 4 or level 5 impact on sites in the area. Minimum construction will entail an office, target launching buildings, walkways, firing stations, and supporting roads.

Conservation Plan Recreational Recommendations

The Conservation Plan lists nature trails, bicycle paths, and horseback trails as facilities to be considered. At present, there are no nature trails and none are planned. Recommendations given as to their best locations are as follows (U.S. SCS, 1970: 89):

> Trails should be located some distance away from heavy concentrations of vehicular traffic and other activities. It is designed so that it is usable in most weather. Planning should take into consideration such items as plants, wildlife habitat, geology, and historical relics or sites (underlining ours, p. 89).

Only one bridle path has been laid out. This and other such activities are distinguished from the other outdoor facilities included in this discussion in that they are under the auspices of the Artillery Hunt Club rather than Recreation Services. In addition, three training areas have also been established. These are located in Rucker Park, at the Bull Pen, and at Hunter Field on Hummel Knob. The Conservation Plan (U.S. SCS, 1970:89) makes the following remarks about horse trails:

> Horseback riding trails are ideally located away from high concentrations of vehicular traffic and people. Monotony should be avoided by laying out the trail to take advantage of most interesting scenery, streams,..., and items of historic interest (underlining ours, p. 89).

Only one bicycle path now exists and none are being planned. It is located entirely on already hard-surfaced roads.

Only nature and horseback trails are intended to leave built-up areas. Bicycle paths then would have little impact on sites but for the fact that they must normally be hard-surfaced. Since, as discussed elsewhere, even so-called "built-up" areas may contain important cultural resources, bicycle paths off of already established hard-surfaced paths carry with them a level 2 impact.

Bridle paths and nature trails carry with them a level 1 impact assuming that sanitary facilities and grading or paving of paths is not necessary. However, another point to consider is the recommendation made in the Conservation Plan and quoted above that these be located to take advantage of historic sites. Particularly with only partially standing historic structures in areas which are not easily monitored, vandalism is possible. In such cases the two goals of education and of preservation might come into conflict. Factors to consider in deter- [illegible]

Fort Sill community as well as support of the installation's training mission are entailed in the non-training activity category.

Important differences exist between these two categories which are reflected in the handling of their individual activity itemizations and assessments. In two reports, the Natural Resources Conservation Report and the Conservation Plan for Fort Sill, specific non-training activities had been delineated to an extent unequaled by the treatment of training activities. These reports were drawn upon in itemizing these while field observations and discussions with members of the USAFACFS staff have provided additional information by which non-training activity impacts were assessed. A further difference between these two categories is that the non-training activities take place primarily but not entirely within the Cantonment area while the training activities (as defined here) occur only outside of the Cantonment. In an attempt to make the broad "training" category somewhat more specific, analysis has been done at the level of its two subcategories "firing" and "non-firing". Further, because of the manner in which the Army reported on its own training operations, that is by activity areas, these subcategories were quantifiable as to amount of specific areal usage. Unfortunately, the specific training activities and their impact on the ground surface could not be well delineated. The overall result is that the scaling of impacts of training activities is necessarily more general than that of the non-training activities. The activity areas of the former have been scaled into "high", "medium", and "low" levels of areal utilization and one man-hour of a firing or non-firing activity is treated as though it has the same damage potential as any other firing or non-firing activity man-hour. As a further consequence of this vagueness, no quantitative comparison can be made between firing and non-firing and between training and non-training activities' potential impacts. Examples of the potential impact inherent in certain specific military operations have been made. In examining the effects of other activities, however, reference should be made to the earlier discussion of the means by which impact damage might be assessed. This basically entails consideration of the depth and extent of ground modification and of the presence of undisturbed archaeological remains and should provide the working basis for further impact damage scalings.

The dangers inherent in attempting to directly equate man-hours of utilization of activity areas with a ranking of potential damage warrants recapitulation. While all firing or non-firing man-hours have been treated as equals that is not to say that all have the same potential impact on cultural resources. Within each subcategory are many activities which are quite varied in their potential impacts. As these form a greater or smaller portion of the total activities within

an activity area, so too will the potential damage to sites in that area

vary. Other factors will also necessarily take the areal utilization ranking further from being an accurate indicator of potential impact. For example, established firing points represent fairly small areas of about 400 meters diameter. In the absence of many other activities in an activity area of large acreage, the intense utilization of a small number of these might result in considerable damage to the area involved—damage which would not be reflected in the ranking of the activity area utilization thus concentrations of a specific activity might be as significant as the type of activity present. These rankings of areal utilization have been created only to facilitate the recognition of long-term problem areas. They should not be used to infer damage to cultural resources without recognizing the assumptions inherent in this overall assessment and the significance of those assumptions. Because of the difficulty in assessing the potential impact of a category or subcategory of activities in a specific area and because of the difficulty in assessing the potential impact of a specific activity in

Chapter 13

ARCHAEOLOGICAL SITE PREDICTION AT FORT SILL

by
Stephen Hackenberger

A predictive model of spatial densities of sites has been derived from the data gathered in the various sampling stages employed during the reconnaissance. This predictive model is presented to enable and facilitate a program of future site detection and evaluation as part of a program of cultural resources management at Fort Sill. The predictive model has relevance only to prehistoric and/or protohistoric sites, since the location of historic sites is commonly based on radically different criteria.

Simple mean densities of sites have been calculated for unsurveyed quadrats on the basis of the edaphic and hydrologic attributes of those quadrats (see chapter 7). This procedure is simply an extension of the final sampling stage, wherin the results of previous stages were used to predict quadrats with high site densities. Those predictive efforts were shown to be successful.

Surveyed quadrats were grouped by observed mean site densities into the following three groups:

1 - high, more than .5 sites/quadrat
2 - medium, between .2 and .5 sites/quadrat
3 - low, less than .2 sites/quadrat

The spatial distribution of the unsurveyed quadrats with these predicted confidence limits of site density are shown in Map 7.

Chapter 14

A REVIEW OF DOCUMENTED HISTORIC SITES AT FORT SILL

by
Daniel J. Crouch

Introduction

The ground survey of a sample portion of the Fort Sill Reservation which was conducted for this project located two historic sites which had not been previously known. It is plainly apparent that Fort

Category 2: the site may be qualified for National Registry nomination; however, circumstances require that nomination be made only following additional considerations

Category 3: the site does not appear to warrant National Registry nomination at this time but does require the protection afforded an important site

Following these individual site discussions, more general observations and recommendations will be presented.

Before discussing the historic sites on Fort Sill, it is cogent to first review those sites which are either presently on or nominated to the National Register. The original nomination forms for these sites have been drawn upon heavily and all quotations are from them unless otherwise noted.

National Register Sites

1. Camp Comanche

This site consists of about 3 acres located on Cache Creek and its east bank 3/4 mile east of the main Post. As stated in the nomination form:

> Colonel Henry Dodge and his Regiment of Dragoons bivouacked here in a fortified camp in July 1834 [sic] after their historic first meeting with the Comanche Indians. The Dragoons were the first American soldiers to penetrate this area of the Southwest. The celebrated frontier artist George Catlin was with this expedition. Other notable members included Lieutenant Jefferson Davis.

2. Blockhouse on Signal Mountain

Located 6 miles west of main Post and 2 miles north of Mackenzie Hill Road, this site was first built in 1871 and later rebuilt in the 1940's. (Figure 14-1)

> Built in 1871 as a signal station and weather observatory to protect outpost stationed there. Messages were relayed by heliographs, semaphore flags, and

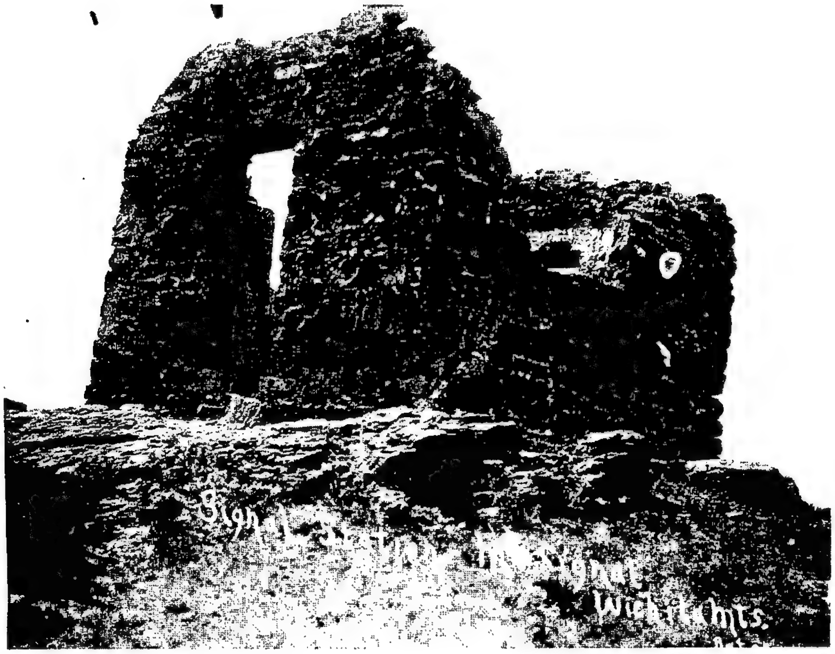


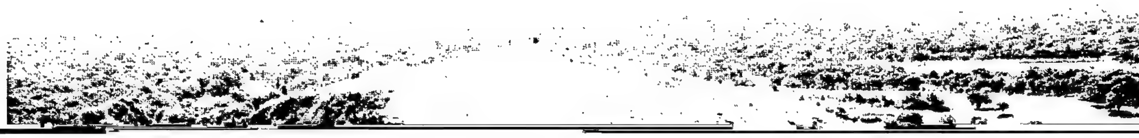
Figure 14-1. The blockhouse on Signal Mountain used to relay messages to the Fort and as a lookout. From the Morris Swett Collection, Museum of the Great Plains.

> signal lamps to inform the garrison at Fort Sill on Indian movements, [sic] and to communicate with other troops. First meterological records for this region were obtained here. The blockhouse has been used as an aiming point by generations of Field Artilleryman.

3. Medicine Bluffs

This site is located between White Wolf Crossing and Four Mile Crossing. (Figure 14-2) A portion of its "statement of significance" reads:

> Prominent landmark noted, described, and explored by all early expeditions and held in deep reverence by the Indian tribes of this area from time immemorial. General Marcy and his Red River Expedition of 1852, and Generals Sheridan, Custer, and Grierson on campaign on 1868-69 are historically associated. The Bluffs are rich in legend as well as history.



5. Patrick Hurley House

This is building #1310 located at 1310 Shanklin Circle, Fort Sill.

> The architecture of Hurley House is representative of the style employed for all of the New Post buildings erected in the period 1909-11, a style that was considered to be particularly adapted to the climate of this region. It is the most imposing set of quarters in the New Post and is located among structures of similar design. This portion of the New Post has remained essentially unchanged in appearance since its original construction.

6. Fort Sill Landmark Area

This area comprises the Old Post Quadrangle (Figure 14-3). In

Fort Sill was established in 1869 in the Kiowa, Comanche, and Wichita Indian Reservation to help maintain the peace but has today developed into the U.S. Army Field Artillery Center. That area on the National Register is related primarily to those early years and includes many of the original buildings.

7. Apache Prisoner-of-War Cemeteries and the Otipoby Comanche Cemetery

These four cemeteries comprising 104.5 acres are located on the East Range of the Post. The Apache cemeteries were begun while members of the Warm Spring, Nedni, and Chiricahua bands were held here at Fort Sill after 1894. All are located on the west bank of Beef Creek. The largest also contains the grave of Geronimo and other famous warriors.

> The Comanche Cemetery at Fort Sill, northwest of Apache cemeteries on a rise overlooking the Cache Creek Valley to the west, was the first cemetery established by the Comanche Indian Tribe when it began to abandon its former practice of isolated burials in remote and unmarked locations. (McClung, 1977:3)

The earliest burial dates to 1888.

8. Flipper's Ditches

This "site" comprises a series of stone-loned drainage ditches in a wooded glade to the west of the present officer's club. These were constructed by Lt. Henry Ossian Flipper of the 10th Cavalry who was stationed at Fort Sill during the late 1870's. These ditches are significant in their association with Lt. Flipper who in 1877 became the first Negro graduate of West Point. During a scandal possibly originating during his station here he was subsequently removed from the Service. His dishonorable discharge has recently been reversed.

Sites Nominated to the National Register

1. Henry Post Airfield

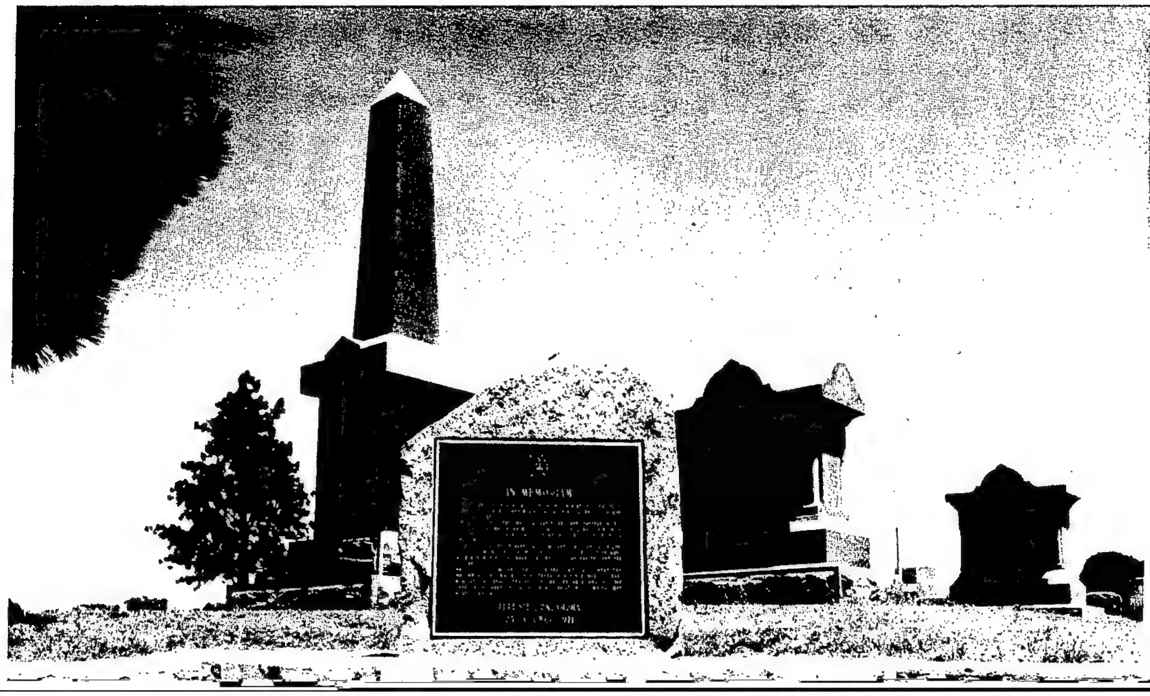
The area under nomination consists of 9 grass-covered acres of the 790 acres which now constitute Post Field. The Field itself is

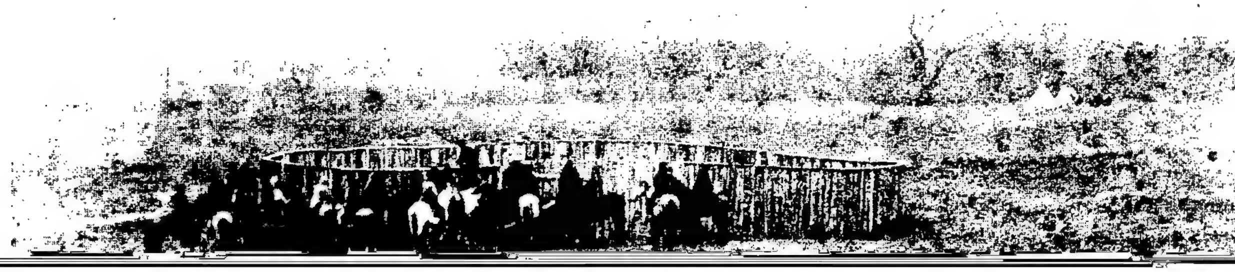
between Highway 277 and Fort Sill Boulevard at the southeast corner of the Post while the nominated area is south of the main parking apron.

The area "in 1915 served as flying field and first tactical station for the first air unit in the US Service, the 1st Aero Squadron." Two years later construction was begun of the Airfield over the same site. Significant events associated with the 1st Aero Squadron are the making of the first aerial mosaic photograph, the first squadron cross-country flight, and the first experiments in airplane observation of artillery fire. Following construction of the Post Airfield over the same site in 1917, the School for Aerial Observers and the Air Service Flying School were established here. Later during World War II it became the center for the training of the Army's artillery "spotter" pilots.

2. Chiefs Knoll, Post Cemetery

This site is located on the highest elevation in the south-central


IN MEMORIAM



3. Ft. Sill Hotel

This site is the location of the picket log structure built in 1869 as quarters for General Grierson. In later years it served as a stage relay station and as a hotel, hence its name. A marker commemorates the location of this structure west of Rucker Park on the lip of the knoll projecting out over Medicine Bluff Creek. It can be seen against the tree line in the background of Figure 14-7.

This is a category 1 site. It is significant owing to its associa-

and as such was the first such construction in the area. It is a Category 1 site and should be nominated to the National Register as an important landmark in the local history of the area. Some architectural significance may also be associated with the structure but has not been considered in this assessment.

In recent years the remnants of this bridge have shown increasing rates of deterioration. It appears that this is due to recent channel straightening of East Cache Creek for flood control. This approach may be useful for that purpose, but increasing the speed of run-off has inadvertently caused increased damage to the Creek areas [illegible] Caddo Bridge is immediately

6. Ice House at Rucker Park

This site manifests itself as a cavity in the terrace edge to the

> was a church, a teachers' home, and an orphanage with two large buildings used as boys' and girls' dormitories (Debo, 1976:429).

One of the mission buildings is reported to have been moved into Lawton and to still exist there.

This church was the one which Geronimo attended during the brief time he was Christianized. It served as a civilizing influence for the entire Apache group providing not only religious and moral instruction for the adults but also secular education for the young. This was but one of several missions to the Indians. While not unique, this mission is significant in that it appears largely undisturbed, has some local notoriety, and served the Apache who were so greatly acculterated over so short a time. It is then placed into Category 2.

3. Wrattan's House

George Wrattan acted as interpreter for Lieutenant Charles Gatewood when Geronimo and his band surrendered to him in 1886. From that time on Wrattan accompanied the Apache as their interpreter through their years of imprisonment. He accompanied them also to Ft. Sill in 1893 and was given quarters north of where the Game Farm is presently located and east of the main Post gate. That house is now gone but almost certainly archaeological remains exist. This site is then assigned to Category 2. George Wrattan, while not a widely recognized name, served in an important capacity during a significant phase of Fort Sill's history. This site is not recommended for immediate nomination to the National Register, but it should be nominated at such time as archaeological testing and documentary research substantiate the location and condition of the structure.

4. I-See-O House

This is the structure provided by the Army for the Indian ex-scout I-See-O and lived in by him for the last years of his life. He was active in government service for most of his life and because of his fidelity and the importance of his services he was given the permanent rank of Sergeant in the United States Army (Nye, 1969:299).

been reported that this structure has been moved from its original location to where it now stands, although this may not have been moved far as Nye (1969:309,311) gives two references to location (i.e. "east of the railroad station" and "near Quarry Hill") both of which refer to the present area. This site is assigned to Category 2. If substantial evidence can be found that it suffered architectural alteration or has been moved, the structure would then more appropriately be in Category 3. In this latter case, the building should be maintained and preserved while a further search is made for its original location. However, if it can be shown that the structure has not been moved and that it meets Register requirements as to modifications, it most certainly should be nominated.

5. Camp Doniphan

During World War I large military encampments were established over the country in order to train the rush of new troopers swelling the Army's ranks. Through the efforts of the citizens of Lawton, one of these, Camp Doniphan, was established at Fort Sill. It was built in 1917 and existed as such until 1919 when most of the buildings were taken down. The National Guard continued to use remnant portions for some time after that although all are gone now (see Nye, 1969:329-331). At its peak, the Camp included 1,267 buildings and could hold 46,183 men (Gibbs, 1918: caption under Plate 10).

Over half of the Camp area has now been either destroyed or greatly damaged. Not only has building construction taken its toll as the Post has expanded, but an underground aqueduct has been laid across it and roads also criss-cross the area. The site is signifi-

separate from the area described above. Camp Doniphan then is a Category 2 site which could become Category 1 following further study.

It is unusual geologically as it is one of only four or five such tar sources shown in the "Mineral Resources Map of Oklahoma" compiled by geologist Kenneth S. Johnson in the booklet Geology and Earth Resources of Oklahoma put out by the Oklahoma Geological Survey.

Historic Sites Summary

The situation of historic archaeological sites is different from that of prehistoric sites. Prehistoric sites are located primarily through the use of field survey techniques. While historic sites may also be located in this manner, it is by no means limited to this approach. The great advantage which historic research has over prehistoric research is its potential for prior documentation. In the past the wealth of records relating to archaeological sites in this area has been largely neglected. Documentation on individual sites has seldom been pulled together for archaeological consideration.

The position of historic sites is also in some ways more desperate than that of the prehistoric sites. Extant early historic sites in this area appear to be quite limited in number, are almost invariably at a shallow depth, and often tend to be located in those same areas which are being intensively utilized today. Further, historic sites have not been considered in the model of predicted cultural resource densities as historic site locations are frequently not subject to all of the same factors which act upon prehistoric site locations. The areas of potential conflict identified in this report have little bearing on historic sites. Because of the damage being done to cultural resources on Fort Sill and because of the unusual nature of historic sites, a more detailed program of historic site identification and preservation should be implemented. The first step in this program should be a broad and intensive documentary research conducted with the goal of identifying the location, associations, and characteristics of the many presently known sites on the reservation. Field reconnaissance and testing should be considered as possible adjuncts to the records survey. These will confirm, clarify, or supplement the documentation.

Not all of the extant historic sites may be located through the use of written records. This survey has located at least two sites which were not previously suspected and for which documentation could not be found. Such sites as these can only be located through field survey. Research of pertinent documents and follow-up field investigation can be considered as only the first part of a program of historic site management.

Two types of historic sites have been dealt with in this report. These are the sites known through their historical documentation and those sites which were first located through the field work entailed in this project. Statements as to qualification for consideration for National Register status have already been made in the individual

discussions of the former. However, some additional summary statements of sites regarding their relationship to National Register status are pertinent.

Certain portions of the early Post not previously discussed were

the use of the Apache prisoners-of-war. This was a frame building on a stone foundation, erected in 1900 and "salvaged" in the mid-1930's. It is said that here is where Geronimo died. While this building has also in part suffered the fate of the stables, archaeological potential yet remains. The same is true for other structures in the vicinity of the Old Post, such as the picket houses to the south and east of the Quadrangle (Figure 14-8).

In addition to the above three small extensions onto the existing Landmark area should be considered the desirability of including as a possible extension of the Landmark area of a strip along both sides of Medicine Creek possibly as far upstream as White Wolf Crossing. This would then encompass such sites as the 1869 Encampment, the Rucker Park Icehouse, and other known but undocumented sites in the area.

One additional modification to the list of sites which should be considered for National Register status needs to be made. The Apache Mission of the Reformed Church, and two of the Apache prisoner-of-war villages discussed earlier (specifically Mangus and Kaateney) are located so as to promote consideration of the entire group as a district. This district entails that area presently referred to as the "Punchbowl." (In addition to these sites, one potentially significant prehistoric site has been located within the Punchbowl.)

With the exception of the above modifications, reference should be made to the earlier site discussions for statements of their individual status. However, a summary of these is as follows:

Category 1 sites:
- Apache Prisoner-of-War Villages (12)
- Beef Issue Pens
- Fort Sill Hotel
- Caddo Bridge
- 1869 Encampment
- Ice House at Rucker Park

Category 2 sites:
- Apache Mission of the Reformed Church
- Wrattan's House
- I-See-O House
- Camp Doniphan
- Chandler Home
- Adams Hill Tar Pits
- Quanah Parker Home
- Grantham's Dugout

In addition to the sites located documentarily are those sites of some possible significance which were located during the field survey of this project. These are Cm-287, Cm-319, and Cm-162. The former two are unmentioned in the records available. The first two appear to have in situ remains and date to at least the turn of the century. Neither, however, appear at this time to be threatened although some pot-hunting was noted at site Cm-287. These sites are presently either of Category 2 or Category 3 status. Particularly if threatened with destruction, however, testing should be conducted at these so as to confirm their dating, associations, and other factors bearing on their significance.

Cm-162 has already been largely disturbed. It is a dump site of restricted dating and associations and as such may in the future prove invaluable in providing an understanding of life at that time. Efforts including consideration of possible National Register nomination should be made so that any further depredation of the site cannot occur.

The foregoing discussion in no way comprises a complete inventory of the historic sites present on the Fort Sill Military Reservation nor does it presume to treat the only sites of significance. Considerations were based first, on available documentation suggesting locations as well as significance associations and second, on an assessment of the likely archaeological potential inherent in the site. The history of Fort Sill is of regional, military, and national importance. The scope of Fort Sill's role in regional and local history as well as the necessity of archaeological research to clarify and enhance many facets of that role, mandates a systematic and thorough effort towards historic site identification and preservation. Clearly the sites which reflect the century-plus of Fort Sill's history cannot be treated here with the attention which is warranted. This task must be the subject of a longer-term program of site identification, evaluation and research which is directed towards the protection and enhancement of Fort Sill's historic past.

Chapter 15

SURVEY OF PLANNED CONSTRUCTION AREAS

by
C. Reid Ferring

Introduction

As specified by the scope-of-work for the Ft. Sill Archaeological Reconnaissance, the reconnaissance area was to include all designated areas of planned construction. These areas were defined by the DFAE and were surveyed entirely for evidence of cultural resources which could potentially be affected by the various construction activities.

Three categories of construction activities were considered in this portion of the survey: general construction sites in the Cantonment area, borrow sites on the ranges, and range pond sites. Lists and areal definitions of the various areas were provided by DFAE. These were selected from larger lists of planned construction which incorporated projects with initiation dates several decades in the future. Consultation with DFAE personnel resulted in an approximate twenty-year cut-off for areas to be surveyed as part of the present reconnaissance. Survey of sites with construction dates in excess of that period was deemed premature with respect to possible changes in both ground exposures at the sites and actualization potentials of the construction plans. Selection of range pond sites from the list of recommended ones set forth in the Conservation Plan was accomplished after a gross ranking of the recommended sites in terms of likelihood of actualization had been completed by DFAE personnel.

As with all other portions of the field survey, each area was systematically covered by foot with all available areas covered as thoroughly as possible. Many of the sites surveyed in the Cantonment area presented unusual survey conditions, however, and exposures were often difficult if not impossible to locate. Correct management of such areas may in some cases require the presence of an archaeologist during early phases of construction, and it would seem reasonable to set some arbitrary "expiration date" on the results of these surveys because of possible changes in ground exposures at these sites. A period of ten years or so for unmaintained areas would not seem an unreasonable period, after which a resurvey prior to construction would be justified.

Construction Projects

A total of 24 separate projects were submitted for survey by DFAE (Table 15-1). All of these are located in or adjacent to the main Cantonment area. Each of these was systematically surveyed. With the exception discussed below, no archaeological sites were discovered and no known archaeological sites occur on the planned construction sites.

[illegible]

Table 15-1. Planned construction areas surveyed.

Priority	Project Number	Project Description
1	92	Trainee Barracks
2	525-76	Hardstand 2400
3	263	Flight Simulator
4	250	Tactical Equipment Shop & Facilities (AIT)
4	257	Troop Support Facilities (AIT) (1st Incr)
4	264	Trainee Barracks Complex
4	265	Trainee Barracks Complex
4	266	Classroom & Logistics Bldgs (ATC)
4	T344	Self-propelled Maint Shop & Facilities (ATC)
4	T396	Troop Support Facilities (ATC) (2nd Incr) (EM Service Club) (Swimming Pool) (Bath House) (Skill Development Center)
5	261	Dental Clinic
6	T434	USAR Annual Training Facilities
7	T446	15 Ammo Storage Igloos & Supporting Facs
8	258	Physical Fitness Center
9	211	Dispensary
10	T445	Flight Simulator (2B31)
11	225	Academic Building (USAFAS)
12	190	Chapel Center (W/REF)
13	T431	Refuse Transfer Station
14	T319	Personnel Services Center (1st Phase)
15	200	Troop Support Facs (HQ & Classroom Bldgs)
16	222	Medical Supply Building
17	T256	Bowling Center
18	79	Tactical Equipment Shops & Facilities
19		Top Soil Borrow Areas

Supporting Facilities (Project T446). This site was collected, and further work was not recommended owing to the presence of similar sites in the immediate area.

Borrow Sites

Eight potential borrow sites were systematically surveyed. One small site (34-Cm-233) was located within the borrow site located just upstream from Pig Farm Crossing. A surface collection was made from this site and it was decided that there was insufficient evidence to warrant testing. The site was therefore cleared for borrowing activities. The site was revisited after some topsoil had been removed from the site during the borrow excavations, and apparently in situ deposits of lithic artifacts and freshwater mussel shell were located in several concentrations. A small sample from one exposure was taken by shovel, and water screened through 1 mm. mesh. The number of small lithic artifacts and mussel shell fragments should have warranted further excavations. By the time this material was processed however, the entire site had been lowered about 1 m by heavy machinery.

Artifacts were located in another borrow site adjoining East Branch Wolf Creek, but the area had been used for borrow excavations some time in the past and the entire area was heavily disturbed. No evidence of archaeological sites was located in any of the other borrow areas.

Range Ponds

Twenty-seven planned or potential range pond sites were surveyed as directed by DFAE (Table 15-2). While the total area indicated for these sites is not large, a considerably larger area was actually surveyed. Buffer zones around each site, probable access routes and borrow sites were also surveyed even though no detailed plans for the sites are currently available. The only site which could be affected is survey site 34-Cm-306 which lies just south of proposed range pond No. MP-3. This site should be avoided by vehicles entering the construction area, and care should be taken to be sure that no borrowing activities take place near the archaeological site.

Table 15-2. Proposed range ponds surveyed at Ft. Sill

Pond #	Surface Acres	Pond #	Surface Acres
E-6	3.0	Q-14	1.0
E-14	5.0	Q-7	10.0
E-15	2.0	W-34	7.0
E-16	3.0	W-22	7.0
E-19	2.0	W-23	3.0
W-17	27.0	W-25	4.0
W-15	1.0	MP-3	52.0
W-13	3.0	W-43	8.0
W-24	3.0	W-45	2.0
W-49	1.0	W-47	2.0
W-5	2.0	MP-6	20.0
Q-6	4.0	E-30	1.0
Q-10	1.5	E-32	2.0
Q-12	6.0		

Chapter 16

ENVIRONMENTAL IMPACT STATEMENT

by
C. Reid Ferring

Introduction

The environmental impact statement prepared as a result of this reconnaissance is structured after the recommendations of Scovill, Gordon and Anderson (1972). As discussed below, certain major portions of the environmental impact statement are presented as chapters in this section and only referenced here.

Cultural Resources Inventory

A detailed inventory of known archaeological sites is contained in chapter 8 and 14. The former describes sites located or relocated by this reconnaissance, while the latter describes certain historic sites on the reservation. At the reconnaissance phase of investigation, site prediction is rightly a part of this inventory, and the site prediction model presented in chapter 13 is intended to aid in this procedure. Cultural affiliations for the known sites are often difficult to assess, particularly when surface assemblages in poor context are as common as those recovered on this reconnaissance. Such terms as "Archaic" or "Plains Village" or "workshop" are not viewed here as being particularly adequate taxonomic units for the description of "cultural affiliations" or "functional associations." The archaeological review presented in chapter 2 has indicated that the state of archaeological knowledge in the region is such that the term "Archaic site" in southwestern Oklahoma has little significance with respect to interpretations of past lifeways. Thus the state of research in the region prohibits

Significance of the Affected Resources

The cultural resources at Fort Sill have historical, scientific and social significance. At this stage of investigation it is appropriate to consider the cultural resources en toto at Fort Sill. Specific levels of site significance are treated elsewhere in the report (chapter 18). Since the reconnaissance has clearly recovered sites which are significant in all three respects, and since only a sample of the affected area has been covered, general treatment of significance here will preclude an unnecessarily lengthy site by site consideration.

Historical significance derives from the potential of a site or sites to contribute to the knowledge of a particular culture, period, lifeway or event (Scovill, Gordon and Anderson, 1972:13). The inadequacy of past regional studies towards the study of specific cultures, their temporal and spatial dimensions, their internal variability, etc. underscores the potential significance of well-preserved sites at Fort Sill to make regionally significant contributions in these areas. Historic sites at Fort Sill offer the potential to document and illustrate important events and personages in the area's early civilian/military history. The stature of Fort Sill during the active period of the western forts lends national as well as regional significance to several specific sites (chapter 14).

Scientific significance derives from the potential of sites to contribute to gains in the formulation of reliable generalizations concerning past societies and cultures (Scovill, Gordon and Anderson, 1972:13). In this sense, much more systematic data bases are usually sought than those which might be necessary to establish historic significance. Statistically valid samples of sites and material culture remains are usually essential for the derivation of supportable statements of relationships among data sets. Settlement pattern studies, for instance, require total surveys of unbiased samples of a given area. In such studies, even surface sites attain significance not generally noted in an historical sense. Preservation or recovery of such samples of sites thus comes into perspective in management spheres. The status of regional investigations is important in establishing scientific significance. The paucity of systematic data recovery from any given subregional area of southwestern Oklahoma again enhances the significance of sites at Fort Sill. At present, the lack of survey data make broad categories of sites at Fort Sill quite significant with respect to such studies. Similarly, the paucity of sites which are well dated, which contain evidence of past activities, subsistence strategies, cultural affiliations, etc. make such sites at Fort Sill quite significant.

Social significance may be attached to the archaeological sites at Fort Sill by virtue of the several ways in which society, particularly the local community, may benefit from their preservation, study and exhibit. A general increase in knowledge of the prehistory and history of the region may be anticipated by preservation and study of those sites. This increase in knowledge would benefit both professional and lay archaeologists by providing information concerning man's past which can enrich their appreciation of their heritage. The acquisition and exhibit of artifacts and structures for public display would provide a direct benefit and pleasure to local and tourist alike. Display of artifacts in museums, preservation of ruins in situ for public view and publicity derived by visits to excavations would give the public a firsthand opportunity to witness archaeological research as well as to gain new insights into the history and prehistory of the area. Creation of permanent exhibits such as stabilized historic site ruins would provide the visitor to Fort Sill with a deeper appreciation for Fort Sill's early years. Such programs would complement more formal educational programs at local institutions institutions designed to privide school children and adults with archeological and historical information. These educational benefits would be of benefit to the civilian and military community, and would serve to provide background on the common history of the military, Indian and civilian populations in this area. Economic benefits could also be anticipated by such programs by enhancing tourism in the area and by providing employment for student excavators, exhibit personnel, etc. Lastly, social benefit may be derived from the archaeological resources at Fort Sill by providing the professional public with data which would contribute to broad research interests dealing with the adaptation and evolution of past societies.

Predicted Affect of Land Use on the Resources

Chapter 12 has outlined in detail the kind and intensity of land use impacts at Fort Sill. These are viewed as potential impacts since many if not most of them appear to be somewhat fluid with respect to the Post's mission. Alternatives appear to exist, therefore, in apparent conflicts between an archaeological resource and a given land use activities directly or indirectly threaten archaeological sites. Losses can be anticipated when potentially significant sites are involved. In general, however, the loss of information incurred by the destruction of a site and its contents will compromise the potential benefits outlined above, thereby depriving many interested lay and professional people of those benefits. The predicted affects of a given activity on an archaeological site maybe evaluated by reference to the potential significance of the site. Such potential significance has been assessed for known sites and is expressed in the recommendations of this report.

Recommended Program for Mitigation of Adverse Affects

A detailed set of recommendations concerning known sites is contained in the following chapter of this report. Recommendations concerning particular land use activities as they may affect sites are contained in chapter 12. Recommendations concerning specific historic sites are contained in chapter 14. All of the recommendations emphasize site preservation and management as opposed to simple mitigation in traditional terms. This philosophy is viewed as having more lasting potential benefits than a short-term period of mitigation, especially in a setting like Fort Sill where many conservation options are available to the cultural resource manager.

Unavoidable Adverse Affects

Truly unavoidable adverse effects of land use at Fort Sill are difficult to assess and qualify at this time. They exist only within a framework of site management which is designed to minimize them. Theoretically, such adverse effects may be almost completely minimized by the careful management of sites and the coordination of training activities about known site locations. In such a program of management, however, a point of diminishing returns is bound to be encountered. At that point it would most likely be more efficient to mitigate losses at a certain site rather than relocate a training or support activity. Adverse effects are bound to be encountered when a significant archaeological site is damaged or destroyed by land use activities. The results of such losses were observed in the field--losses which have occurred over the long years of Fort Sill's operations when active programs of cultural resources management were not practiced on such installations (see chapter 11). Certainly other unavoidable losses will be encountered in the future despite efforts to preclude them. Buried sites may be damaged by normal training or maintenance operations; losses then will be effected before the site is known to exist. In general, however, unavoidable adverse impacts must be weighed against positive efforts to minimize losses and maximize benefits to be derived from cultural resources management. Such positive efforts have been well initiated by this reconnaissance. An effective program of site preservation and management offers the possibility of achieving impact minimization via site preservation. Such a program, when integrated into existing facets of the mission, should permit site management without excessive mitigation, and without substantive change in any facets of the mission. Site management, it should be noted, is vastly more inexpensive than mitigation.

Alternatives to Proposed Action

In a setting such as that presented by Fort Sill's land use activities, the alternatives available to the cultural resource manager are considerably more rich than in many other management situations. In an evaluation of the potential impacts at Fort Sill (chapter 12) numerous alternatives to existing operations were itemized. Site avoidance is the single most attractive option for site management at Fort Sill. When a training or non-training activity locus may be moved slightly to avoid a site, numerous benefits can be attained at a bargain price. A site may be preserved for future study, a costly mitigation may be rendered unnecessary and a mission-related operation may proceed normally.

Sampling is another attractive option for the cultural resource manager. If a particular type of site may be located consistently enough in similar settings and with similar cultural associations, then preservation and/or mitigation of a representative sample of such sites may be implemented.

Mitigation is an option to an adverse impact when the location of a site and a deleterious activity cannot be segregated. Mitigation, however, is only an effective alternative when that mitigation is designed to accomplish specific goals. The latter include regional goals concerning regionally specific problems or discipline-oriented problem formats which maximize contributions of the mitigation to contemporary theory and methodology. Simple recovery of artifacts or "relics", in other words, does not constitute mitigation.

Chapter 17

RECOMMENDATIONS FOR A PROGRAM OF CULTURAL RESOURCES MANAGEMENT AT FORT SILL

by
C. Reid Ferring

The following recommendations reflect the perceived need for an ongoing program of cultural resources management at Fort Sill. Such a program, in lieu of a brief period of mitigation, is deemed appropriate for several reasons. First, the varied and sometimes fluid nature of land use activities at Fort Sill render the absolute definition of impacts a difficult process. Second, the nature of those activities is such that site preservation is a very viable alternative to deleterious impacts on cultural resources sites; site preservation is regarded as the most desirable of alternatives given a situation of adverse impacts. Third, the exposure and location of sites at Fort Sill is often accomplished after some disturbance has been incurred, making frequent monitor and evaluation procedures necessary. Fourth, this reconnaissance has suggested that additional testing and survey would be necessary to fully deal with cultural resources sites on the reservation. Fifth, full realization of the positive benefits from cultural resources management at Fort Sill can be expected by an in house program of fieldwork, research and educational programs.

The first and most important recommendation to be made is that an in house program of cultural resources management be created at Fort Sill. This program should be designed to effect certain other recommendations listed below and also to engage in the facilitation of site management and enhancement within extant training and non-training programs of land use. This program should be integrated into existing land use operations, such as the Post Engineers', Range Controls', Range Conservation, etc., such that communication between various land use operations and archaeological staff is maximized. Direct affiliation with the Directorate of Facilities Engineering appears to be the most expedient locus for the archaeological staff, although such a decision is beyond the scope of these recommendations.

The archaeological management program should be minimally staffed by a professional archaeologist holding at least an M. A. in Anthropology with a major in archaeology and demonstrated experience in fieldwork and cultural resource management. This person should

design and implement, in coordination with various land use operations at Fort Sill, a continuing program of survey, testing and site management which would serve the long term interests expressed in the environmental impact statement presented above. Coordination of the archaeologists' activities with the conservation and exhibit capabilities of the Fort Sill Museum should be effected in order to maximize the educational and display benefits of the program.

In addition to the creation of such a program of cultural resources management at Fort Sill, the following specific recommendations are made with respect to aspects of that program:

1. Additional survey of portions of the reservation are warranted given the results of the reconnaissance. This survey can be made more productive and more efficient be reference to the results of the site and impact predictions made in chapters 12 and 13 of this report. Continued sampling, as opposed to total survey is thus viewed as an option given an ongoing program of management, with a point of diminishing returns being sought by the program. In chapters 12 and 13, three levels of site density and three levels of land use intensity were recognized and presented visually on enclosed maps. These levels can be employed to structure future survey. The recommended program of survey may best be indicated by cross tabulation of the predicted site and land use categories as follows:

	LAND USE INTENSITY		
	HIGH	MEDIUM	LOW

Intercorrelation of the maps provided with this report would allow

c. It is recommended that the following sites be given high priority on a preservation schedule, since potential significance is high:
34-Cm-20, 69, 71, 241, 246, 299, 323, 307, 310, 313, 319.

II. Sites not Elligible for Nomination to National Register

a. It is recommended that the following sites be pre-

Chapter 18

SUMMARY

by
C. Reid Ferring

The Fort Sill Archaeological Reconnaissance was carried out between 1 October 1976 and 1 July 1977 by the Museum of the Great Plains for the Corps of Engineers, Ft. Worth District for the purpose of assessing the kind and number of cultural resources located on the reservation and the real and predicted impacts of Ft. Sill's land use activities on those resources. To achieve this goal, a minimum 15% surface reconnaissance accompanied by ancillary field studies, archaeological test excavations and laboratory studies was employed. Presented below is a summary of the goals of the project, the results of the investigations and the recommendations pertaining to the management of known and predicted cultural resources sites at Fort Sill.

The problem orientation of the reconnaissance revolved about established goals of archaeological reconnaissances as defined by the Corps of Engineers (33 CFR Part 305; Federal Register, Vol. 40, No. 174). In essence, these goals include "a literature and records search, plus an on-the-ground survey of a portion of the area adequate to assess the general nature of the resources present and the probable impact of a project." Primary aspects of this task include the ascertainment of the significance of the resources, and, given that the survey area will "normally not exceed 15% of the total project area," a valid predictive model of the cultural resources sites present as indicated by the survey results. The widely accepted posit that the significance of an archaeological resource must be couched in terms of discipline-wide and regionally defined problems has played a significant part in the problem orientation as well as the implementation of this reconnaissance.

The most salient aspect of the literature review for Fort Sill and the region (essentially defined as Southwestern Oklahoma) is the extremely low status of scientific archaeological investigations relating to the cultures which have inhabited the area over the last 11,000 years. One could almost, in fact, view the area's prehistory and history as *terra incognita*. From an anthropological perspective, the main problems center about the delineation of processes of cultural change and their relationships to adaptive mechanisms to both the natural and cultural environment. At the regional level, the identification of

indigenous cultures at various periods, the study of their specific adaptive mechanisms, settlement patterns, their internal and external cultural relationships as well as their role in ethnographically known historical events stand out as prominent tasks for archaeologists to undertake. Since the significance of any cultural resources located at Fort Sill is intimately related to these regional and discipline-wide considerations, it became clear that the poor status of scientific investigations at the regional level would necessarily increase the potential significance of sites which might be located on the reconnaissance.

For purposes of cultural resource management, another facet of the reconnaissance is significant: the range of both kinds and intensities of land use activities at Fort Sill is highly complex. The definition of these potential impacts, the determination of their relationships to both known and predicted cultural resources and the establishment of a plan of management of those resources has proved to be a more complicated task here than in most cultural resource management situations.

The following summary of the results of the reconnaissance reflect the overall approach to the problems as briefly summarized above. Intermediate results, such as the ancillary studies and the impact evaluations are all essential to the formulation of an environmental impact statement. The latter, briefly summarized below is highly dependent on the significance of the cultural resources. Since the context of a given resource, the status of scientific investigations in a region, the number of similar resources in a region, etc. are all integral parts of any evaluation of significance, their treatment here is deemed crucial.

TABLE 18-1. Areas Surveyed at Fort Sill by Survey Phase

Survey Phase	Area Surveyed sq. km.	acres
1. Planned construction		
buildings	1.836	453.7
borrow sites	1.545	381.8
range ponds	1.338	330.6
2. Streams		
East Cache	4.389	1,084.5
Medicine	1.655	408.9
Blue Beaver	1.508	372.6
Crater	.606	149.7
West Cache	1.014	250.5
Post Oak	.990	244.6
3. Quadrat Survey		
Phase I (soils)	23.25	5,744.8
Phase II (hydrol.)	18.25	4,509.4
Phase III (soils/hydrol.)	12.50	3,088.6
TOTAL	68.881 (18.04%) of Fort Sill	17,019.7

it was avoided during construction. In sum, the potential impacts of planned construction at Fort Sill appear to have minimal potential impacts on cultural resources.

The second phase of survey dealt with a stipulated, minimum one-third survey of six of the major streams which flow through the reservation. These were defined on the basis of visible alluvial features and were sampled either randomly or systematically for survey. This portion of the survey covered approximately 10 sq. km. (ca. 2,500 acres) and resulted in the location of 32 archaeological sites.

The third phase of survey involved sampling of the entire reservation for the purposes of site location and prediction. All areas were sampled with the exception of the impact areas. The latter proved to be logistically unfeasible to enter, owing to nearly constant scheduling conflicts with training activities as well as hazards from duds. These factors were

deemed as nearly interminable impediments to any archaeological invest-
igations in these areas. Reconnaissance suggested that

TABLE 18-2. Characteristics of Sites Located at Fort Sill.

Site	Size sq m	Condition*	Impacts[1]	Recommendations*	Work Completed[1]
34-Cm-233	1,680	destroyed	borrow	–	Ct,T
34-Cm-322	–	1	pipes	NR	T,A
34-Cm-69	7,000	3	FP	1	Cs
34-Cm-68	150	3	R	T	Ct
34-Cm-67	6,000	3	FP,R	T	Cs,A
34-Cm-234	6,000	5	FP,R	–	Cs
34-Cm-235	700+	3	R,Fx	T	Cs
34-Cm-58	24,000	5	R,E,Fx	–	Ct
34-Cm-236	250	3	R,Fx	T	Ct
34-Cm-74	–	3	V	–	Cs
34-Cm-237	2,500	4	E	–	Cs
34-Cm-238	–	5	V,E	–	Ct
34-Cm-239	10,000+	2	R,Fx,E	NR	Cs,T
34-Cm-93	4,500	4	FB	–	Cs
34-Cm-240	200	2	E	NR	Cs,T
34-Cm-241	200	2	E	1	Cs,T
34-Cm-242	100	5	R,E	–	Ct
34-Cm-38	2,500	3	R,E	T	Cs
34-Cm-243	–	3	I,R	T	–
34-Cm-244	–	5	–	–	Ct
34-Cm-245	250	5	–	–	–
34-Cm-92	–	4	FB	2	Ct
34-Cm-246	16,000	3	I	1	Cs
34-Cm-247	450	5	R,E	–	Ct
34-Cm-248	60	5	E	–	Ct
34-Cm-249	20,000+	1	FP,R,E	NR	Cs,T
34-Cm-20	–	2	FP,Fx,R	1	Cs,T
34-Cm-250	100	5	V	–	Ct
34-Cm-26	4,000	3	E, Ch	2	A, T

TABLE 18-2. Cont'd.

Site	Size sq m	Condition*	Impacts	Recommendations*	Work Completed[1]
34-Cm-275	-	1	E	T	Cs
34-Cm-276	180	5	FP	-	Ct
34-Cm-277	3,600	4	FP,E	-	Cs
34-Cm-278	-	1	Ch,E(channel)	T	-
34-Cm-72	7,500	3	R,E	T	Cs
34-Cm-279	-	1	-	2	-
34-Cm-71	4,000	2	R,Fx,E	1	Cs,T
34-Cm-280	-	4	R	2	Cs
34-Cm-281	2,500	5	R,E	-	-
34-Cm-282	5,000	5	E,V	-	Ct
34-Cm-283	4,800	5	V,E,FP	-	Ct
34-Cm-284	-	5	B,E	-	-
34-Cm-285	24,000	5	E,R	-	Ct
34-Cm-286	-	5	R	-	-
34-Cm-287	2,800	3	potting	2	-
34-Cm-288	4	4	-	-	Ct
34-Cm-289	400	4	V,E	-	Ct
34-Cm-65	1,000+	4	R,E,B	T	Cs
34-Cm-290	18,000	5	FP,R,E	-	Cs
34-Cm-162	-	5	pipe	2	-
34-Cm-291	1,800	4	R,E	2	Cs
34-Cm-292	3,600	5	FP	-	Ct
34-Cm-293	400	5	-	-	-
34-Cm-294	4,200	4	-	-	Ct
34-Cm-295	1,800+	3	P	T	Ct
34-Cm-296	400	5	E	-	Ct
34-Cm-297	-	3	P	2	Ct
34-Cm-298	-	4	FP	2	Ct
34-Cm-299	400	4	V,E	1	Ct
34-Cm-300	-	5	-	-	Ct

TABLE 18-2. Cont'd.

Site	Size sq m	Condition*	Impacts[1]	Recommendations*	Work Completed[1]
34-Cm-301	8,000	4	-	-	Cs
34-Cm-302	750	3	R,FB,P	2	Ct
34-Cm-303	3,600	5	V,E	-	Cs
34-Cm-323	300	1	E,R,Fx	1	Ct,E
34-Cm-304	7,500	5	R,E	-	Ct
34-Cm-305	12,00	5	FB,P	-	Cs
34-Cm-306	6,000	3	FB,V,E	T	Ct
34-Cm-307	200	3	-	1	Ct
34-Cm-308	6,000+	4	-	2	Ct
34-Cm-309	120	5	E	-	Ct
34-Cm-310	10,000	4	V	1	Cs
34-Cm-311	6,500	5	V	-	Cs
34-Cm-312	16,000	5	R,FP	-	Ct
34-Cm-313	800	3	V	1	Cs
34-Cm-314	-	3	R	2	-
34-Cm-315	-	4	FB,R,E,FP	2	Cs
34-Cm-316	1,600	5	V,E	-	Cs
34-Cm-317	8,500	4	P	2	Cs
34-Cm-318	3,500	4	E	2	Cs
34-Cm-319	-	2	-	1	-
34-Cm-320	2,800	5	FB,Fx	-	Cs
34-Cm-321	-	3	R,E	2	Ct

*see text for explanation

[1]impacts:

Ch - channeling
R - road
FB - firebreak
V - vehicle traffic off road
FP - firing point
P - plowing
E - erosion
Fx - foxhole/ trashpit excavation
I - impact area
B - borrow pit
\- - none

work completed:

T - test excavations
E - partial excavation
Cs - surface sample collected
Ct - total surface collection
A - augering
NR - National Register

1. _in situ_ occurrence with preserved organic remains (8.53%)

2. _in situ_ occurrence with no organic remains, but significant stratigraphic or intrasite patterning of artifacts probably present (7.32%)

3. possibly _in situ_ deposits of unknown character (24.39%)

4. surface site, good preservation of horizontal artifact provenience (21.95%)

5. surface site, total loss of intrasite artifact [illegible]

interpretation of sites' geomorphic settings, particularly as these relate to paleoenvironmental conditions as well as intersite comparisons. This survey proved useful in establishing preliminary geomorphic sequences for the area, in providing initial intersite comparisons probably relevant to substantive past geomorphic events and also provided information relative to the densities of archaeological sites associated with alluvium in different portions of the reservation.

A botanical survey was carried out at Fort Sill in order to provide first information on the detailed botany of the area which could be used for the reconstruction of past ecological relationships. This survey provided abundant new data relating to the identification, density and variability of the vegetation in the Fort Sill area. Many of these data were integrated into the site catchment studies as well as for purposes of regional evaluations.

Only one site--Pig Farm Crossing (Cm-26) appeared to contain evidence which might bear on the paleoenvironments of the Fort Sill area. Acquisition of those data were deemed important for the evaluation of potential fluctuations in paleoclimates which could have relevance to diachronic patterns of settlement pattern changes as well as ecological relationships. Considerable efforts to obtain both radiometric and paleoclimatic data from the site were thwarted largely by the lack of pollen in the exposed sediments. Delineation of regional paleoclimates remains as an important gap in local prehistoric studies. Faunal studies were carried out on the small sample of bones recovered from site Cm-322 and the human burial from site Cm-323 has been analyzed. The latter represents the first systematic study of a prehistoric burial from Fort Sill and one of the few in the region.

Radiometric analyses of samples from both archaeological and geological exposures have been undertaken in order to provide at least initial information on the cultural and natural chronology of the area. Thus far, only the ca. 1430 A. D. date from site Cm-322 has been received. That date should prove to be a significant one however, as it indicates the strong possibility that the site represents one of the latest pre-contact manifestations in the region.

A thorough review of all known historic archaeological sites located on the reservation was performed, and all sites on or nominated to the National Register of Historic Places were reviewed. These reviews resulted in a number of recommendations relative to the status of those sites with respect to their assessed significance.

Impact evaluations were conducted for the important task of ascertaining the kind, intensity and distribution of land use activities on the reservation. This proved to be an ominous task owing to the diversity of the activities and the difficulty of locating them precisely in a setting of necessarily fluid training programs. Many non-training activities also proved difficult to assess and characterize spatially. Projected distributions of the locations and intensities of land uses at Fort Sill were prepared. These offer important information for the cultural resource manager since they provide, in association with the known and predicted site locations, a means to estimate areas of highly probable adverse impacts on cultural resources. In addition, specific activities have been evaluated in terms of potential impacts they may have on archaeological sites in order to facilitate their relationships to a program of cultural

Second, recommendations were presented which dealt with the anticipated conflicts between predicted site locations and characteristics and land use activities determined to be potentially deleterious. These recommendations are complex in their implications for they deal with both predicted site locations as well as predicted land use activities. Since preservation has been given priority over mitigation in these studies, added complexity has surrounded these recommendations since more numerous alternatives to adverse impacts have been recognized. In brief, it has been recommended that areas of high potential conflict between archaeological sites and deleterious impacts be surveyed entirely. Areas with moderate levels of predicted conflict should be sampled so that possible impacts may be better evaluated. Areas with low levels of predicted impacts should not need survey, unless some specific factor bears on an area. The final selection of new survey areas, the accomplishment of these surveys and the actualization of a program of testing and site preservation all argue strongly for the need of an in-house archaeologist at Fort Sill.

Lastly, recommendations were presented which pertain to the sites located on the survey (Table 18-2). These have been categorized, their relative frequencies being a highly simplified predictor of the remaining resources potential research/preservation requirements. The description of the recommendations and primary alternatives, with frequencies of sites in each category are as follows:

Code	Site Frequency	Recommendations and Alternatives
Group 1: Elligible for Nomination to National Register		
NR	4.82%	Place site on National Register, preserve; mitigation necessary if adverse impacts unavoidable.
T	15.66%	Testing necessary to fully evaluate site; preserve or test for fuller appraisal of significance.
1	13.25%	Preserve site with high priority; inability to preserve means appraisal of other similar sites necessary to decide on mitigation plans.

Code	Site Frequency	Recommendations and Alternatives
Group 2: Inelligible for Nomination to National Register		
2	18.07%	Preserve with low priority; site type common and some maybe lost without serious impacts, but site group must nonetheless be managed.
–	48.19%	No further work of any kind necessary.

Again, the desire to preserve rather than mitigate has led to some complexity here. Nonetheless, almost half of the sites located would require no additional work (note, however, that most have been partially analyzed as part of this project) and almost 20% more would need be preserved only with low priority. This pattern suggests that the management of the remaining sites would be quite feasible logistically. The need of a trained in-house archaeologist to perform the kinds of necessary field and laboratory evaluations to implement as full a program of site preservation as possible cannot be overstressed. Such a program is viewed as a means to minimize mitigation costs, maximize preservation potentials and increase the overall beneficial impacts of Fort Sill on these cultural resources through a systematic plan of management.

Appendix A

THE PARADE GROUND SITE (34-Cm-322): ARCHAEOLOGY

by

C. Reid Ferring and Richard Vernon

Investigations at the Parade Ground Site (34-Cm-322) revealed a large, in situ occupation site which contains abundant data relating to the material culture, subsistence and absolute chronology of the occupations. It is apparently a late prehistoric village covering a large portion of the Old Post Quadrangle Parade Ground and possibly some adjacent areas as well. Brief test excavations at the site, limited to three one square meter test pits and several auger holes were designed to recover basic data relating to the cultural affiliations of the site, its age, and its potential for yielding information important to reconstructing the setting and character of the occupations of the site. To varying degrees these goals were accomplished and more kinds of data were recovered from this site than from any other on the survey. Still, many problems could not be addressed during these investigations, and the site remains one of the most promising cultural resources described in this report. Since this site is located in the heart of a National Registry area, the form for the Old Post National Historic Site is simply being amended to include this previously unknown prehistoric component.

The site is located in the northern portion of the parade ground in the Old Post Quadrangle. Augering was conducted to aid in the estimation of the horizontal extent of the site, but this was restricted to the parade ground proper and did not extend north of the street bounding the northern edge of the quadrangle. Later trenches placed just north of the service road behind Sherman House did not reveal any artifacts or features, suggesting that the northern limit of the site is between the street and the service road.

There are virtually no surface indications of the site since the area is one of the most carefully maintained lawns at the post (Figure A-1). The site was discovered by personnel from the Ft. Sill Museum when a series of narrow trenches were placed in the north central portion of the parade ground for the installation of a permanent public address system. These trenches were approximately 15 cm wide and 30-40 cm deep. Abundant chipped stone, charcoal, bone and a few

sherds were observed in the backdirt from these trenches and the site was called to the attention of the Fort Sill Survey personnel. Testing was initiated as soon as there was a break in the ceremony schedule for the parade ground. Studies at the site were deemed important owing to the paucity of late prehistoric sites in the region as well as the necessity of ascertaining the potential significance of a site located in the center of the post. The possibility that this site might be the location of one of the Wichita Villages mentioned by several mid-nineteenth century travelers to the Medicine Creek area (Bell and Bastian, 1967) served as an additional impetus to define the nature of the occupations. None of those villages reported along Medicine Creek have ever been located.

Methodology

The strategy employed in the testing operation was to define the horizontal and vertical extent of the site, acquire a sample of artifacts and faunal materials, obtain a sample for radiometric dating and ascertain if plant macrofossils were present in the deposits. Test squares, each one square meter in area were employed to recover the samples of materials listed above. Augering was employed to aid in the definifion of the horizontal and vertical extent of the site.

The test squares were placed where it appeared that the ground was undisturbed and where the ditching suggested high artifact and faunal material density. An old sidewalk and a gazebo site in the north end of the parade ground limited the area for testing. The two initial pits were placed between the site of the gazebo and the north street and on either side of the old sidewalk. These squares were thus 24 meters apart and approximately parallel with the north edge of the parade ground.

Each of the squares was excavated in arbitrary levels, 5 cm deep and maintained by a line level below an arbitrary datum. One quadrat of each level was bagged in the field and was processed in a floatation machine (Figure A-1,c). The other material was screened at the site through 1/4" hardware cloth and the residue bagged and wet sieved through 1 mm mesh at a nearby stream. Thus, all of the faunal materials and artifacts reported here were recovered from 1 mm mesh. Charcoal samples were collected in the field, by level. Several large faunal elements had to be treated with ducotone in the field and removed separately. After sorting of wet sieve or floatation heavy fraction, all matrix was hand sorted into gross categories of

bone, stone and ceramic material. All faunal elements were submitted to Dr. Barbara Butler for analysis. All lithic and ceramic artifacts were labelled when size permitted (thousands of chips, each less than 3 mm in maximum dimension, were recovered). This report includes the results of the analyses carried out on all of the artifactual materials while the faunal studies are included in Butler (this volume).

Site Setting

With its historical surroundings removed, the Parade Ground Site may be seen as occupying one of the more favorable locations in the southern fringers of the Wichita Mountains area. The site is located on the northern edge of a broad level bench overlooking Medicine Creek just west of its confluence with East Cache Creek. Just below the site are free flowing springs which in historic times were tapped for the Fort's early water supplies. Extensive areas of fertile alluvium occur below the site owing to the effective merging of the Medicine and East Cache Creek floodplains. In historic times the bench was treeless but the dense galleries along the creek supported dense growths of burr oak, pecan, elm and other trees (see Robertson and Hoestenbach, this volume).

Stratigraphy

Two essentially similar profiles were exposed through the excavations of squares 1/3 and 2. Approximately 40 cm of deposits were exposed in both of these areas. The most important aspects of these shallow profiles are the records of occupational history. These have been reconstructed on the basis of vertical distributions of artifactual and faunal materials, and consist of a prehistoric occupation (of main concern) and the period relating to the occupation of the site after 1869. Three main stratigraphic units have been recognized which pertain to both of the areas of excavation. These should be relevant to most other areas of the site, with the exception of the portions of the site which were more heavily disturbed by sidewalks and the gazebo. These latter areas were avoided during these investigations and will not be treated further here. The characteristics of these three stratigraphic units are as follows:

Unit	Depth	Characteristics
I	0–10 cm	This dark greyish brown silty loam represents the modern soil

Unit	Depth	Characteristics
		and contains artifacts of early historic age (internal primed cartridge, cut nails, etc.). At the bottom of the level a distinct layer of scattered plaster was observed in square two, probably relating to the ground surface at

maintenance. Given the historic records of later Wichita Villages in the area the possibility that some of the artifacts in the upper levels of the site may represent ephemeral historic Wichita occupations of the area must be entertained, although there is no way to seriously cope with such possibilities here.

The minute area tested allows for little speculation as to intra-site patterning of artifacts or other materials and no such problems will be addressed here beyond noting that the two areas tested (squares 2 and 1/3) appear to have quite different densities of certain artifact categories (Table A-1). Such problems would have to be studied with the aid of much larger excavation areas.

Augering was employed to aid in the determination of site size. A series of auger holes, each 10 cm in diameter and 40 or 50 cm deep were dug in transects east, west and south of the test pits. The matrix from these auger holes was bagged by ten cm levels and later water screened through 1 mm mesh. The artifacts and bone recovered from these auger samples was simply counted by level. Artifacts and bone were recovered in every auger sample. The densities of these materials of course was low in absolute terms, but the volume of the auger hole is only .00785 that of a one square meter pit the same depth, so the positive results of these may be taken as strong indications that appreciable <u>in situ</u> deposits are represented by these samples.

Dating

A single charcoal sample was submitted to the Radiocarbon Laboratory, Institute for the Study of Earth and Man, Southern Methodist University for radiometric analysis. The sample consisted of small chunks of charcoal dispersed throughout level 5 (20-25 cm below ground surface) of square 3. A date of 399±98 years B.P. (1551 A.D.) (SMU-405) was obtained from this sample.

Material Culture

The test excavations clearly demonstrated a high density of cultural refuse at the site. Nonetheless, the very small area excavated has not yielded a sample of materials which may be regarded as valid for the purposes of full characterization. Thus despite the apparently adequate samples of certain artifact forms described here, final definition of the assemblages of artifacts from the site should await fuller investigations,

Table A-1. Lithic and ceramic artifact densities by level at the Parade Ground Site*

Level (5 cm)	Square 1 a	Square 1 b	Square 1 c	Square 3 a	Square 3 b	Square 3 c	Square 2 a	Square 2 b	Square 2 c
1	–	–	0.1	–	14	1.6	3	1	1.3
2	–	–	0.3	–	2	1.8	–	–	0.7
3	9	24	12.2	14	38	14.2	1	15	9.1
4	15	23	16.7	15	40	11.9	5	53	20.9
5	–	4	6.7	1	8	7.5	3	36	18.3
6	–	3	3.1	–	–	1.9	2	6	7.6
7	–	1	–	–	–	–	–	1	0.7
8	unexcavated			unexcavated			–	1	1.3
9	unexcavated			unexcavated			–	1	0.9
Total	24	55	39.1	29	102	38.9	14	113	60.8

*Note squares 1 and 3 are contiguous. a– ceramic sherds; b– lithic artifacts (greater than 1/4"); c– chips (weight in gm.)

With the exception of the later nineteenth century artifacts in the upper levels of the site, there were no artifacts whatsoever of European manufacture located by these investigations. These items were

and much more bone than ceramics. This may well be due to intra-site differences, but this cannot be evaluated at present.

Chipped Stone

The chipped stone assemblage posed analytical problems owing to the very small size of the artifacts. The tools are the largest pieces in the assemblage, and most of the other spalls could be called chips. An arbitrary size classification was imposed, with pieces falling through a 1/4" mesh screen being called chips and the larger pieces called debitage. Raw material identifications were not performed on the chips since pieces of such small size may not accurately be classified in most cases. Many of the chips could be identified into some of the more easily recognized categories, but they would probably have been biased therefore in frequency counts. Despite the apparently large debitage sample (239 pieces) very few of these are complete, making quantified technological analyses inappropriate at this time.

Table A-2. Raw material useage in the Parade Ground Site lithic assemblage.

Raw material type	Debitage No.	Debitage %	Tools No.	Tools %
Alibates	12	4.7	3	10.0
Edwards	76	31.9	8	26.6
Florence	1	0.4	1	3.3
Frisco	20	8.4	-	
Kay County	36	15.2	4	13.3
Ogallala	1	0.4	-	
Clear Quartz	(present in chips)		-	
Quartzites	3	1.2	-	
Tecovas	1	0.4	-	
Wichita Mountains	5	2.1	-	
Unidentified chert	84	35.3	14	46.66
Total	239	100.0	30	99.8

activities. This observation must be made most tenuously, however, since intrasite patterning of activities could easily be involved. The fantastic number of small chips may bias the impression of tool maintenance for these will not be recovered without the fine screening. Several samples of 100 chips were weighed in order to allow estimates of the numbers of chips from each unit. These provided an estimated average weight of 0.01475 gm per chip. Thus, level 3 of square 1 has an estimated 827 chips since the total weight of chips in that level is 12.2 grams. Using the same procedure, it is estimated that these test squares yielded approximately 9410 chips. Despite the possibly significant error using this technique it is clear that there are many, many chips per tool in this assemblage. Since less than a dozen pieces of debitage exhibited cortex, it seems safe to assume that most of these chips relate to either final tool manufacture or tool maintenance. The size of the pieces are most likely representative of pressure retouch (Henry, Haynes and Bradley, 1976), although maintenance of both bifacial and unifacial tools would probably be involved.

Tool Class Descriptions

Projectile points- Of the six projectile points recovered, three are distal fragments. The complete ones include a side-notched triangular point with a concave base (Figure A-2, a), one with an irregularly placed side notch (Figure A-2, b), and a small unnotched

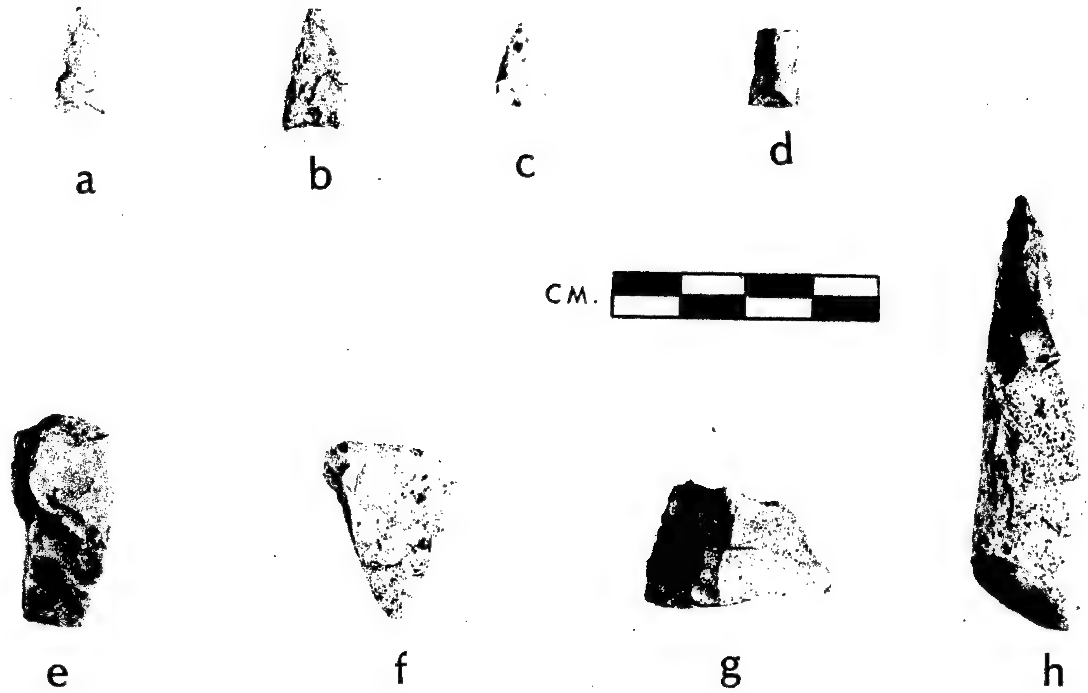


Figure A-2. Lithic artifacts from the Parade Ground Site. a-c- projectile points; d- drill mid-section; e- end-side-scraper; f- simple end scraper; g- simple sidescraper; h- reamer/scraper.

triangular point (Figure A-2, c). The complete points are small, with length of 16.3, 18.8 and 12.6 mm respectively. Mean thickness for all points is 1.96 mm. Each of these points appears to be of the Fresno or Washita variety.

Scrapers- Six of the scrapers are side scrapers (most of which are formed by steep, invasive retouch (Figure A-2, g). One simple end scraper with a straight scraping edge was recovered (Figure A-2, f) and the others are all combination end-side scrapers (Figure A-2, e).

Drills- Two drill fragments were located. One is a tip and the other is a mid-section (Figure A-2, d). Both have been bifacially flaked into thick, biconvex cross-sections.

Knife- One tool tip has alternate bevelled retouch forming a point. This very closely resembles the retouch on bevelled knives, yet the piece was apparently not completely bifacially flaked since the ventral surface of the flake blank is discernible.

Multiple tool- One piece has been extensively retouched into an elongated tool which contracts to a sharp drill or reamer tip (Figure A-2, h). The sides have steep scraper-like retouch while the base is partially thinned by bifacial retouch and is heavily worn.

Notch- A single flake with two deep but narrow notches on one laterial edge constitutes this tool class.

Retouch pieces- Each of these pieces is a flake with continuous thin retouch along one or two edges.

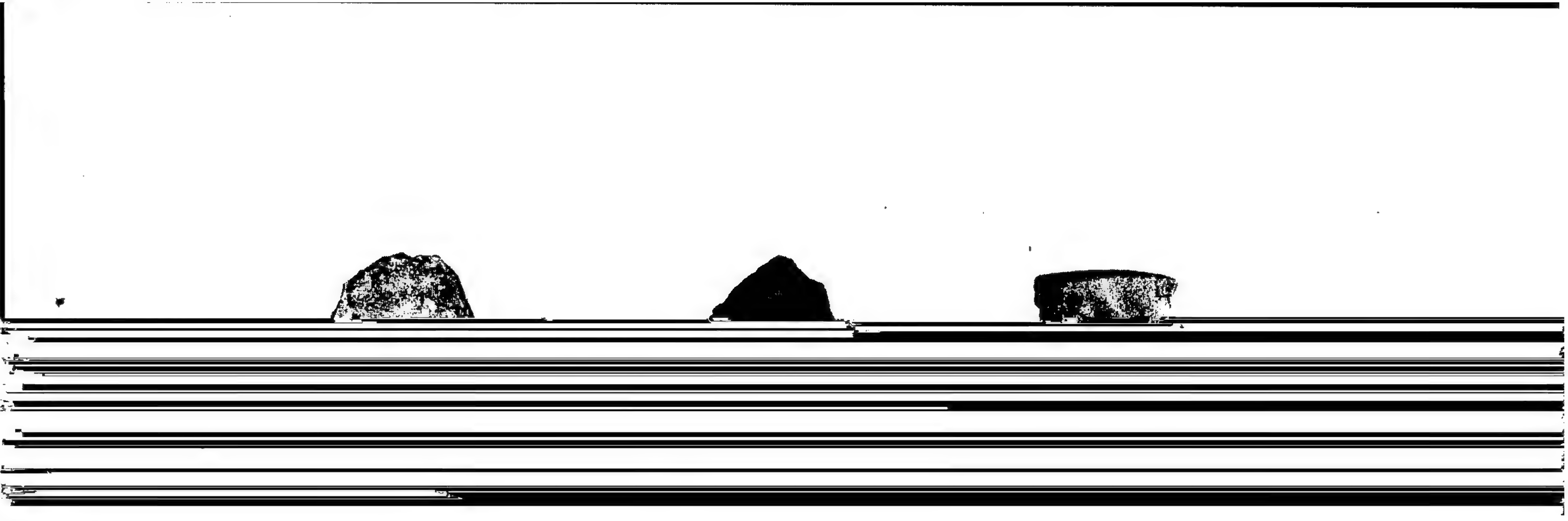
Bone artifacts- Five bone artifacts, four beads and one awl tip were recovered. The awl tip is round but too small to assess overall [illegible]

Ceramic descriptions - Parade Ground Site (34-Cm-322).

Color		Surface Texture		Mean Thickness (mm)
xterior	Interior	Exterior	Interior	
3/2-dark rown; 3/1-very ark gray	5YR 5/6-yellowish red; 7.5YR 3/2-dark brown; 5YR 4/4-reddish brown	grainy with temper exposed incised lip	same as exterior	6.53
3/2-brown/ ark brown; 6/4-light rown	7.5YR 3/2-dark brown; 10YR 5/2-grayish brown	smooth with pits formed by dis-solving temper. dull or matte	same as exterior	7.66
4/3-brown/ ark brown; 5/2-grayish rown	10YR 3/1-very dark gray (smudged)	polished-smooth, even, lustrous	same as exterior	8.75
4/2-brown/ ark brown; 3/2-dark rown	7.5YR 4/4-brown/ dark brown; 7.5YR 3/2-dark brown; 10YR 4/2-dark grayish brown	polished. some areas missed. not as well done as group 3.	same as exterior	6.54
3/2-dark rown	2.5YR 3/0-very dark gray	surface is even but not polished. 3 parallel lines are incised in the surface.	highly polished	8.70

Table A-3. (Continued)

Group	No. Sherds	Temper	Color Exterior	Color Interior	Surface Texture Exterior	Surface Texture Interior	Mean Thickness (mm)
6	15	crushed granite grit, angular quartz particles	7.5YR 4/4-brown/ dark brown 7.5YR 5/4-brown 7.5YR 3/2-dark brown	same as exterior	surface is smooth but not polished.	same as exterior except some are peeled on interior.	7.84
7	3	sand and some bone	5YR 3/2-dark reddish brown 2.5YR 4/4-red-dish brown 5YR 4/2-dark reddish gray	7.5YR 6/4-light brown 7.5YR 4/2-brown/ dark brown	smooth but not polished.	same as exterior	8.26
8	1	crushed granite	10YR 5/3-brown	7.5YR 4/2-brown/ dark brown 10YR 2/1-black	brushed with parallel striations	very smooth but not polished.	9.2
9	1	bone and crushed granite very abundant	5YR 2.5/1-black	2.5YR 2.5/0-black	exterior is indented with rounded, over-hanging rim.	plain and dull	5.7



Appendix B

FAUNAL ANALYSIS OF MATERIALS FROM THE PARADE GROUND SITE (34-Cm-322)

by
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Nature of the Sample

The faunal elements recovered from the Parade Ground site at Fort Sill are extremely fragmentary and homogenous in nature. A total of 37,228 pieces were recovered from three 1 square meter test pits. Table B-1 presents the total number of bones from each level of the three units and the number of those fragments which are burned and identifiable. As can be observed, the vast majority of fragments were recovered from levels below 10 cms. The enormous number of fragments recovered and presented for analysis is due to the fact that a 1 mm size mesh was used for screening. The relative importance

Table B-1

Distribution by excavation unit and level of the osteological remains

Unit 1				Unit 3				Unit 2			
uare tal	Number burned	Number unburned	Number I.D.	Square total	Number burned	Number unburned	Number I.D.	Square total	Number burned	Number unburned	Number I.D.
53	38	15	0	172	153	19	0	269	194	75	13
24	22	2	0	574	535	39	0	66	16	50	1
574	1998	676	15	251	215	36	0	873	570	303	8
280	3717	1563	38	4614	3687	927	52	4397	3370	1027	14
379	1035	344	16	4130	2907	1223	12	4486	2347	2139	12
540	423	117	10	5915	5067	848	8	1246	642	604	3
7	3	4	2	5	0	5	0	109	59	50	2
nexcavated				unexcavated				85	38	47	2
excavated				unexcavated				79	55	24	0
57	7236	2721	81	15661	12564	3097	72	11610	7291	4319	55

N	%
228	
091	72.7
137	27.2
214	.6

es and tooth fragments.

Few big pieces of large mammal bones were recovered. These include a scapula (Bison/Bos) from Square 3, Levels 5-7 and fragmentary long bones from Square 3, Level 4, and Square 1, Level 5. These pieces include sections of ribs (the least useful bone for species identification according to Olsen, 1961), and unidentifiable sections of long bones. One example is a complete shaft section of what is most likely a metapodial. The 130 mm long fragment has a circumference of 145 mm.

The large bones recovered are fairly soft and have a tendency to splinter; the scapula demonstrated this. The very dense metapodial shafts and other compact bone areas are well preserved, however. The small fragments from long bones are generally very dense; flat bone fragments are softer and tend to splinter more easily. In general, the burned elements are very well preserved and quite hard.

The fragmentary nature of this sample could result from several factors. The unusual nature warrants consideration and continued investigation. Below are suggested several plausible explanations; they fall into two categories: 1) Treatment by the original site occupants and 2) Post-depositional treatment.

1) It is possible that the Indians either pounded the bones into these small fragments during the utilization process or this fragmentation happened as a result of their disposal techniques. Descriptions of the process for the extraction of grease from bones include the details of smashing long bones into very small pieces (Leechman, 1951; Grinnell, 1972; Bonnichsen, 1973). Another possibility is that the unedible remains were thrown into a common area which was burned frequently. The fragments could have resulted from breaks along the natural fracture lines which are accentuated during the burning process (Baby, 1954).

2) This area has been continuously used as a parade ground for the fort since 1869 and it is possible that the bones have been broken up as a result of the parade ground preparation and use. It is conceivable that large machinery used to level the field, maintain the grass, etc. in addition to any heavy military pieces moving over the area would have contributed to their fragmentation. Weathering agents such as alternating wet and dry periods, either as a result of a sprinkler system or natural rain cycles, could also cause the bone to break along their natural fracture planes.

In addition to the bone being so highly fragmented, the high percentage of burned bone is a noteable characteristic of this sample

(Table B-2). Although 72.7 percent of the total sample of bone recovered was burned, the percentage of burned bone for each excavation unit varies from 96.6 per cent to 24.2 per cent. Nineteen of the 21 units excavated have more than one-half of the recovered sample exhibiting burning characteristics (Table B-2).

Table B-2. Frequency and percentage of bone fragments burned for each excavation square.

	Square 1		Square 2		Square 3	
Level	N	%	N	%	N	%
1	38	71.6	194	72.1	153	88.9
2	22	92.6	16	24.2	535	93.2
3	1998	74.7	570	65.2	215	85.6
4	3717	70.3	3370	76.6	3687	79.9
5	1035	75.0	2347	52.3	2907	70.3
6	423	96.8	642	51.5	5067	85.6
7	3	42.8	59	54.1	–	
8	unexcavated		38	44.7	unexcavated	
9	unexcavated		55	69.6	unexcavated	

It is possible that a cooking technique was being used that caused the bones to be burned, or it is possible that they were burned after disposal. Given the nature of the area, it is less likely that they were burned after the site was abandoned by the original occupants. It is also possible that the burned bones have been favored for preservation because of the added strength imparted by the burning.

The greatest percentage of the burned bones are black in color. The proportion of black bones (indicating charring) to white, gray, blue (indicating a hot, direct burning, (Baby, 1954) was figured for Level 4 of Square 1 with 5280 fragments. These pieces were counted and only 4.7 per cent of them were white. Although the other squares were not quantified in this manner, visual inspection suggests that this proportion is representative for the rest of the excavation unit.

SPECIES IDENTIFICATION

The analysis of these materials consisted of an initial sort of the unidentifiable from the possibly identifiable materials. At the time of this sort, the burned unidentifiable fragments were separated from the unburned and each was counted. The others were identified with the aid of a comparative skeletal collection and any that could not be identified were replaced in the unidentifiable sample and so recorded.

Only 194 (.5 per cent) of the elements were identifiable to species. Eighty-three per cent of these came from Levels 3-5 (Table B-1). As can be observed in Table B-3, the number of species identified is very small. It is unfortunate that little subsistence information can be gleaned from this sample.

Table B-3. Species identified from the Parade Ground Site

Name		Number of Pieces
Box Turtle	Terrepene sp.	140
Cottontail Rabbit	Sylvilagus sp.	2
Badger	Taxidea taxus	16
Deer	Odocoileus sp.	19
Bison ?	Bison bison	14
Cow ?	Bos. sp.	1
Tooth Fragments	sp?	11
Rodent Phalanges	sp?	9
Bone bead Fragments	sp?	2
Total		214

Seventy-two per cent (140) of the total fragments identified were turtle carapace and plastron elements. The genus represented is most likely Terrapene, but the osteological remains are not large enough

Table B-4. Number of elements recovered by provenience for selected species

Level	Square 1			Square 2			Square 3		
	Turtle	Deer	Bos/ Bison(?)	Turtle	Deer	Bos/ Bison(?)	Turtle	Deer	Bos/ Bison(?)
1				13					
2						1 (Bos?)			
3	8	1		3		1			
4	9	11	1	7	6	1	50		2
5	12		5	2	1	1	9		2
6	10			3			8		
7	2			2					1
8				2					
9									
Total	41	12	6	32	7	4	67		5

Many non-identifiable long bone elements were recovered and they ranged in size from very small mammals to deer sized individuals and even some extremely large, thick fragments representing mammals the size of Bison/Bos. These were recovered from all levels.

It is most probable that the large mammal elements from levels below 10 cm are Bison. Those above 10 cm are most likely Bos. There is a very low probability, however, that some of the large fragments could represent elk. Elk would have been available to the site inhabitants in the Wichita Mountain area. Bison, of course were in the Mixed-grass Plains district and possibly in the Wichita Mountain area as well (Blair, 1939). Early appearance of Bos is not well documented. It is possible they were there as early as the late 17th century. Horses were in the area at least by the later 1680's (Newcomb, 1961).

The identification of these elements is based more on the archaeological context than on the osteological remains. It is extremely difficult, even with complete bones to distinguish Bos from Bison elements and these remains, at best, are fragmentary. Historic materials were recovered from the first 10 cm and the C^{14} date suggest the lower levels to be prehistoric. This would then preclude these large mammal bones from being Bos elements unless they were instrusive and there is no evidence of that. The distribution of Bison?/Bos? elements in this site is presented in Table 4. In addition to the relatively complete Scapula only one Tarsal 2+3 was complete and identifiable. The others are big fragments of large bones; the articular ends, however are not present. None of these large sections had been burned.

A vertebra, which is more likely Bos than Bison, was recovered from Square 2, Level 2. It has been cut with a saw through the centrum; the piece present is the right half. The individual was not mature as the epiphysis on the centrum had not completely fused at the time of death. This bone has not been burned.

There were some small and medium sized rodent and other small mammal phalanges recovered, but they do not have distinguishing characteristics permitting identification. Also, a number of dental fragments were recovered, but due to their fragmentary nature they were not identifiable even to type of tooth, let alone species. The majority of these fragments are enamel pieces which have split and broken away from the dentin.

Two fragments which could have been beads were recovered from Square 1, Level 5. They are longitudinal segments of a cylinder; possibly these two half sections fit together at one time, they are not now reconstructable. There is a groove in each, coursing roughly perpendicular to the long axis of the tube. One section is 7.1 mm long; the other is 7.3 mm long. An estimated circumference is 24 mm.

DISTRIBUTION IN THE SITE

The generalization can be made that the bone density was the greatest from levels 4 and 5 in all excavation squares. Only three additional 5 cm levels demonstrate this same dense distribution, and are continuous units to levels 4 and 5 (Square 1, Level 3 and Square 2, Level 6, and Square 3, Level 6). Level 1 of Square 2 is an anomoly in that so many identifiable pieces were recovered (Table B-1). The thirteen pieces are all small pieces of turtle shell.

Levels 4 and 5 also contained the largest pieces of bone recovered, and the greatest number of identifiable pieces. Square 1, Level 4 yielded the badger elements, box turtle shell pieces, and an enamel section of deer teeth. Large sections of Bison (?) ribs and metapodial (?) pieces were recovered from Level 5. Level 4 of Square 2 contained the tarsal of a Bison (?) and Level 5 had a variety of identifiable forms including the cottontail rabbit elements, Bison (?) bones and the well-preserved deer molar. Large unidentifiable bison/deer (?) pieces were also recovered from Level 4 of Square 3, in addition to the 50 turtle shell fragments (Table B-4). A non-quantified impression of Square 3 is that there are relatively more big bone fragments as compared to the other two squares.

A wide variety of mammals would have been available to the inhabitants of this site. The Mixed-Grass Plains district, in which Fort Sill is situated has representatives of 56 mammalian species. Of all the biotic districts in Oklahoma, this one has the largest number of different species represented. The nearby Wichita Mountain district as 25 different species of mammals represented (Blair, 1939). About 17 species are the same for both the Mixed-Grass Plains and the Wichita Mountain district; thus there were about 62 different mammalian species available to these people within a 4-5 mi. radius. Certainly mammals could have played an important part in the subsistence of the occupants of the site.

SUMMARY

This sample of osteological materials is most interesting in terms of the nature of the sample and the distribution of the materials at the site. Although it is obvious that vertebrates were an important resource, unfortunately the lack of identifiable bone inhibits analysis in terms of such questions as subsistence, seasonality, use of bone as raw material for tools, decorations or other cultural modifications, and other aspects traditionally analyzed. It is possible however, that the large number of small bone fragments results from extracting bone grease.

Appendix C

HUMAN SKELETAL REMAINS FROM (34-Cm-323)

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An extremely fragmentary skeleton was recovered from site 34-Cm-323. The remains consist of fragmentary cranial elements, dental elements both *in situ* and *loose*, and several fragments of long bones from the right side of an immature individual[1]. Although the cranial, dental and mandibular elements are from both the right and left halves

Figure C-1. Burial from site 34-Cm-323 during excavation. Note rodent hole running from base of skull to former position of knees. Portion of humerus lies on leg at end of another rodent hole.

a line just slightly distal to the first premolar. The postcranial remains were too fragmentary to observe any of the usual sites of morphological variation.

No unusual variations were observed in the dentition, but the teeth are complete and so more observations were possible. The primary

No morphological observations were possible on the deciduous teeth due to the degree of attrition. The enamel had been completely worn off the occlusal surface. The molars exhibited stage three attrition in that more than two islands of dentin had coalesced (Greene, Ewing and Armelagos, 1967). The deciduous maxillary teeth shows more severe wear than do the mandibular teeth.

The erupted permanent dentition exhibited 1+degree of attrition. There is evidence of enamel wear, but none goes through to expose dentin. The three six-year molars (tooth 6 above) which are present, as expected, exhibit the greatest amount of wear in the permanent teeth.

The first and second mandibular molars (teeth 6 and 7 above) all have five cusps and Y fissure patterns. The one third molar present (8) has a 4+ configuration. None has a paramolar trait. The maxillary incisors (1 and 2) are all moderately shovel-shaped and without a tuberculum dentale. The canine ridges on the one maxillary canine present (3) are weak. Neither of the two maxillary molars present (6 and 7) exhibit a Carabelli's trait. The maxillary 1st molar has the normal four cusps and M2 has 3 cusps.

Severe banding (hypoplasia) was observed on the maxillary first incisors and canines (1 and 3) and the mandibular canine (3) near the cervical area. It is a wide area of disturbance. It is most likely that this is a result of dietary deficiency or disease which were present between the fifth month _in utero_ and the first year of postnatal life (Clement, 1963). At sometime during the enamel development phase, the necessary minerals were not provided by the environment. No other dental disease was observed; no caries or abscesses were present.

Although the long bones are very broken and few complete cross-sections were present, it is suspected that there is thickening of the cortical bone of some of the shafts (diaphyses) of the long bones. It is impossible to determine which bones they represent. The compact bone

Ninety per cent of the cases of osteomyelitis are caused by the Staphlococcus aureaus bacillus and this disease occurs most frequently in children under twelve. Further, it is two to four times more frequent in boys than girls in the sample from modern U.S. medical statistics. This proportion is attributed to the higher incidence of trauma in young boys (Aegerter and Kirkpatrick, 1963).

Osteomyelitis is associated with a trauma to a bone, certain types of anemia, and other infections. A child with this disease is quite ill with a high fever and chills. The pain in the area is extreme and is associated with tenderness, swelling, increased warmth and redness.

The swollen, irregular appearance of the bony elements results from the separation of the periodsteum from the underlying bone by pus. This causes new, irregular bone to be formed on the shaft. This remodeling can happen very soon after the disease is contracted and can advance to a stage of extreme deformity. The disease was not very advanced in this young individual.

In summary, then, the remains recovered from this excavation include two individuals, the one adult represented by only a few small pieces of an occipital area, and the fragmentary remains of a nine-year old individual. Because the teeth are moderately shovel-shaped, this individual was probably an Indian, but no other cultural remains were recovered to verify this.

The left half of the skeleton had probably eroded out of the bank and all that is left are the fragmentary remains of the right side. These exhibit a mild case (or early stages) of what is probably osteomyelitis.

The wear of the decidious teeth is relatively severe for an individual of that age, suggesting considerable grit in the diet.

A Note on the Archaeology of 34-Cm-323

by

C. Reid Ferring

Location of the burial eroding from the creekbank prompted excavation owing to the precarious situation of the remains. Two one square meter pits were opened up above the burial, and were removed in 5 cm levels. The matrix from these levels was water screened through 1 mm

mesh. No artifacts or other bone elements were recovered from these screenings. Further, no outline of a pit could be discerned in the profiles of the excavation, although other stratigraphic observations were made at the site (Hall, this volume).

A very sparce scatter of lithic artifacts was found above the burial, primarily in the dirt road which passes nearby. Local disturbance, including a wildlife plot and several deep foxholes, revealed no additional evidence of artifacts or features at the site.

In the absence of any demonstrated association of the burial with in situ artifacts makes dating quite difficult. Bone from the burial has been submitted for radiocarbon dating, however, in hopes of establishing the broadest of possible cultural associations (Archaic, Plains Village, etc.).

Appendix D

LITHIC ARTIFACT CODING PROCEDURES AND SITE DATA

Prior research in southwestern Oklahoma has suggested that for many of the prehistoric sites in the region lithic and ceramic artifacts from surface collections will offer the bulk of the data bearing on the temporal, cultural and functional aspects of the occupations of the site. Traditionally, a few diagnostic artifacts have been used for drawing inferences with respect to these problems. The use of projectile points for dating purposes is most frequently encountered despite the fact that the age and duration of any given point style is poorly documented at this time by independent data. For the most part the use of these "type fossils" has proved to be adequate only for gross dating-between the Plains Archaic and the Plains Village stages for instance- which is aided in some cases by comparative ceramic analyses. Functionally directed lithic studies are less commonly encountered in the literature for the region, and these are not frequently executed at the assemblage level.

Although technological studies are becoming increasingly more common aspects of lithic analysis, their potentials for cultural, functional and temporal inferences concerning an assemblage have been scarcely investigated. It is towards these ends that the following classification of attributes and artifact classes has been directed. The apparent complexity of the observations may be better understood when the goals of the lithic analysis and the role of the lithic analysis is examined. The former entail the description of each assemblage typologically (using commonly employed types or artifact classes) technologically (defining some consistent technological parameters of each assemblage and, when possible, defining reduction strategy (ies) within each assemblage) and defining the raw materials for each assemblage. By way of oversimplification it may be stated that the technological aspects of these analyses are multivariate problems for which the analysis of attribute relationships must be undertaken. This alone requires the recording and analysis of multiple attribute states which may be related to a reduction philosophy.

In addition to the site number and the intra-site provenience, the artifact type or class, the raw material and a number of observations [illegible]

Table D-1. Lithic artifact coding form.

I. SITE NUMBER

II. PROVENIENCE

III. ARTIFACT CLASS

01 Debitage
02 Core
03 Blank/Preform
04 Other Biface
05 Projectile Point
06 Scraper
07 Retouch
08 Notch
09 Denticulate
10 Drill/Perforator
11 Ground Stone
12 Other
13 Burin
14 Hammerstone
15 Gouge

IV. RAW MATERIAL

01 Alibates chert
02 Basalt
03 Edwards-like chert
04 Florence chert
05 Frisco chert
06 Kay Co. chert
07 Madera chert
08 Obsidian
09 Ogallala
10 Quartz (A)
11 Quartz (B)
12 Springfield chert
13 Tecovas jasper
14 Thyolite
15 Mora River chert
16 Wichita Mountain jasper
17 Misc. chert
18 Misc. other

IV. RAW MATERIAL (cont'd)

19 Sandstone
20 Granite
21 Keokuk chert
22 Limestone
23 Medicine Creek chert

V. PLATFORM TYPE

00 Indeterminate
01 Cortex
02 Single facet
03 Multiple facets
04 Crushed
09 Not applicable

VI. DORSAL SCAR PATTERN

00 Indeterminate
01 Cortex
02 Unidirectional
03 Bidirectional
04 Multidirectional
09 Not applicable

VII. CORTEX

00 Indeterminate
01 None
02 1 - 25%
03 26 - 50%
04 51 - 75%
05 76 - 100%
09 Not applicable

VIII. PLATFORM THICKNESS

Measured to 0.1 mm

IX. PLATFORM WIDTH

Measured to 0.1 mm

Table D-1. (Cont'd)

X. ARTIFACT LENGTH

Measured to 0.5 mm

XI. ARTIFACT WIDTH

Measured to 0.5 mm

XII. ARTIFACT THICKNESS

Measured to 0.1 mm

XIII. CORE CLASS

00 Indeterminate
01 Single Platform
02 Opposed Platform
03 Multiple Platform
04 Bifacial, LT 90^{o}
05 Bifacial, GT 90^{o}, LT 180^{o}
06 Bifacial, GT 180^{o}, LT 270^{o}
07 Bifacial, GT 270^{o}, LT 360^{o}
08 Bifacial, 360^{o}
09 Not applicable

XIV. BLANK FORM

00 Indeterminate
01 Nodule
02 Flake
09 Not applicable

attributes and attribute states. These data were coded on standard Fortran forms and were later key punched. The descriptions below qualify the attribute observations and define the characteristics of each attribute and/or attribute state.

I. Site Number

The site number corresponds to the trinomial system, with the state (34) county (Cm) and site number.

II. Provenience

The intra-site provenience was recorded, indicating the surface collection unit, square and level, etc. When applicable, artifacts from Schaeffer's collections were added to the samples and were coded as provenience "00."

III. Artifact Class

A highly condensed artifact classification system was used owing to the overall sparsity of tools and cores from the sites as well as the ability to further analyze by use of additional attributes. Debitage, [illegible]

to artifact "types") with the objective of discerning technologically oriented patterns of both intra- and interassemblage variability.

01 Debitage- this class consists of any spall removed from a core which exhibits clear indications of intentional fracture (bulb of percussion, platform, etc.) but shows no secondary retouch.

02 Core- this class consists of either masses of raw material in natural form or flakes which exhibit removals of spalls for further use. The pattern of spall removal indicates that the mass or flake was not being reduced bifacially.

03 Blank/Preform- these artifacts are either masses of raw material in natural form or flakes which show removal of spalls indicating initial stages of bigacial reduction. The lumping of these two classes recognized by Crabtree (1972) was done in view of the progressive phases of attributes (such as width/thickness ratios, percentage

were arbitrarily put into this class. All such fragments exhibited very fine bifacial retouch along their edges indicative of final tool trimming.

06 Scraper- this class includes all forms of scrapers, i.e., pieces secondarily modified with continuous, steep or semi-steep retouch which has modified an edge into a well defined straight or convex edge and which is invasive, forming a shoulder usually at least 2 mm high from the edge of the retouch.

07 Retouched Piece- this class of tools exhibits continuous, secondary retouch of one or more edges of a spall. The retouch may be either flat, steep or semi-steep.

08 Notch- these tools consist of spalls with one or more secondarily retouched notches, which have been formed by semi-steep or steep retouch.

09 Denticulate- these tools consist of spalls which have been secondarily retouched such that saw-toothed retouched edges, consisting of at least three contiguous notches are present. The notches may be either retouched or single-blow or combinations of these.

10 Drill-Perforator- this class consists of tools with retouched projections made by either unifacial or alternate retouch

15 Gouge- these distinctive tools are usually bifacially prepared, are plano-convex or concave-convex in cross-section and are cordiform (or almond shaped) with straight or more frequently concave bases or "bits". The [illegible] are [illegible] in terms of function.

An exceptionally large sample of lithic artifacts was submitted to Mr. Banks since it was not possible for him to examine the collections personally. This sample was drawn on the basis of observable variability in the raw materials in the samples from a large number of sites at Ft. Sill. Every effort was made to provide all observable ranges in colors textures and gross categories of rocks (flint/chert, jasper, chalcedony, quartzite, igneous rocks, etc.). The sample thus consisted of an intuitively based representation of all the lithic raw materials present in the samples from all of the sites. It did not constitute a random sample of all artifacts or a proportional sample of the actual categories of rocks, since certain distinct categories (such as Ogallala) were not repeatedly selected. These materials were examined by Mr. Banks and identifications were made largely through comparisons with his extensive specimen collection. Those materials in the submitted sample were identified and bagged separ- [illegible]

sample submitted to Larry Banks were identified as to specific localities, including: Ft. Hood, San Angelo, North Fork San Gabriel, San Gabriel near Georgetown, Texas, Kerrville. These samples are characterized by considerable variability in color, ranging from dark bluish-grey to white, and by less variability in texture. Subsequent to these identifications by Mr. Banks, small cobbles of local chert were located in gravels of Cache Creek which are similar to some of the white varieties of Edwards. The materials probably derive from as yet undefined sources in the limestone hills north of Meers, Oklahoma. The large number of specimens identified by Mr. Banks strongly suggest frequent movement of lithic materials from Texas to the north. Some ambiguity must be admitted however, with respect to identifications of certain varieties of Edwards as opposed to some materials of local origin. These ambiguities may only be resolved when detailed investigations of local materials are performed by a geologist.

04 Florence- this chert derives from the Barneston Formation, as does Kay County variety of Florence. Banks (n.d.) lists Cedar Creek, Kansas as a source for Florence, and characterizes it as being medium to dark blue grey, but lightens with weathering and has "small hair-like white inclusions".

05 Frisco- this chert is predominantly white, but colors range from "pale yellow and cream to light mottled red, grey and white" (Banks, n.d.:11). Banks reports that this is the most limited lithic resource in northeastern Oklahoma (with outcrops near Marble City, and the type locality located in the eastern Arbuckles near Fittstown, Oklahoma. Banks (personal communication) indicates that some of the specimens from Ft. Sill may be of local origin and thus not Frisco <u>per se</u>.

06 Kay County- this flint is one variety of flint which outcrops in the southern Flint Hills of Kansas and Oklahoma. It is a nodular and tabular flint characterized by banding, yellow to light blue grey color and abundant fossils (Banks, n.d.: 21). Heat treating (commonly observed in archaeological samples) produces a higher luster and a pink or red color.

07 Madera- this chert outcrops in northern New Mexico but probably was obtained from gravels in Pleistocent terraces of

the Red or Canadian Rivers (Banks, personal communication). The few specimens identified are very fine grained, light brown to white and transluscent.

08 Obsidian–very few specimens of this material were recovered, and none in good contexts. Sources for the material are not known, but logically should be located in the southern Rockies.

09 Ogallala chert- the name for this material varies from chert to quartzite; the latter seems to represent its textural characteristics best. Lopez and Saunders (1973) suggest that either name can be used, but that this highly variable material is probably a series of silicified siltstones and sandstones some of which have been cemented by chert. This is by far the most abundant raw material represented both within Ft. Sill and in the archaeological assemblages from Ft. Sill. This material is highly variable in texture, but less so in color. Finer-grained examples are the less common, but exhibit quite good fracturing characteristics despite their hardness. Coarser grained materials are frequently unsuitable for knapping. Colors are dominated by grey interiors with slick but irregular, reddish cortex. Outcrops of this material are common in the Southern Plains, but are apparently restricted to regions of late Tertiary and Pleistocene channels. Gravels from these channels, often reworked, contain Ogallala and other materials which originated in the eastern slopes of the Rockies. Thus distributions in the Southern Plains are often splotchy. At Ft. Sill, this material was observed to be abundant among the eastern portion of the east range, just west of the Cantonment from Medicine Creek to the south boundary, and north of the Cantonment in the open terrain near Apache Gate. Only sporadic finds of isolated cobbles were noted elsewhere, and none was observed west of Blue Beaver Creek within the confines of the Reservation.

10 Clear Quartz (Quartz A) – these pure quartz crystals occur as outwash in the gravels of Blue Beaver, Crater, and more abundantly in West Cache and Post Oak Creeks. They derive from nearby sources in the Wichitas. Large single crystals or clusters of crystals which are free from flaws may be easily found in those streams.

11 Quartzite (Quartz B) – these materials vary considerably in color and texture, but all appear to be quartzites of local origin. They have the same distribution as the Quartz crystals, but also occur with some Ogallala outcrops.

12 Springfield quartzite- this material is represented only by a few specimens which are fine-grained quartzites or silicified sandstones. Origins appear to be in northwestern Oklahoma and southwestern Kansas or in gravels of rivers draining that region.

13 Tecovas jasper- this material derives from outcrops in the Lano Estacado and gravels of the Canadian and probably Red Rivers. It is grossly similar to Alibates, but has a more mottled appearance and is dominated by yellow, tan and deep red colors.

14 Rhyolite- this material is abundantly available from local outcrops (see Map 1). Much of it is very fine-grained and suitable for knapping. Both red and black varieties have been observed locally.

15 Mora River- several specimens were identified by Banks (personal communication). The specimens are characterized by mottled whites, yellows and tans and by a lustrous fine grained texture. These specimens were indicated by Banks as being similar to materials collected on the Mora River, near Watrous, New Mexico.

16 Wichita Mountain jasper- this is a local, but poorly known material. It most frequently is a medium to fine grained jasper, deep red in color, but sometimes black and often with blotches of white or yellow. It is known from one outcrop near the western edge of the Wichita Mountains Wildlife refuge, about eight miles north of Indiahoma, Oklahoma, but other sources may well exist.

17 Miscellaneous chert- this large group of materials includes all unidentifiable cherts, some of which may be locally available. Variability in this category is too marked to attempt description.

18 Miscellaneous non-cherts- this category includes all non chert materials which could not be identified.

19 Sandstone-this category includes several forms of sandstone, all of which appear to be locally derived.

20 Granite- these are all locally derived materials (Map 1).

21 Keokuk chert- the specimen described by Banks is one of the several varieties discussed in Banks (n.d.) which derive from outcrops in the vicinity of the Grand River in Northeast Oklahoma and adjacent portions of Arkansas and Missouri.

22 Limestone- this category refers to several varieties of apparently silicious limestone which derive from the limestone hills north of Ft. Sill. These occur in gravels of Medicine and East Cache Creeks and in some cases appear to have been knapped or used as hammerstones.

V. Platform Type

to. This attribute is usually used in coordination with the percentage cortex observation for spall analysis.

00 indeterminate- the spall is to small to assess the patterning of the dorsal flake scars or for some other reason (such as burning) they cannot be identified.

01 cortex- the entire surface of the spall is covered with cortex.

02 unidirectional- all of the scars on the dorsal surface of the spall originate at the proximal (bulbar or platform) end of the piece.

03 bidirectional- the scars on the spall indicate preparation from both the proximal and distal ends of the piece.

04 multidirectional- the dorsal scars indicate complex preparation, i.e. the preparatory blows originated from at least two major directions, one of which is generally perpendicular to the axis of spall removal (an axis defined by a line connecting the platform and the distal extremity of the spall).

09 NA

VII Cortex

The amount of cortex on the dorsal surface of a spall is a general indicator of the stage at which the spall was removed. Depending on the particular reduction strategy being employed however, this attribute may have quite different interpretations. In bifacial reduction systems it is generally agreed that decortification and preforming are necessary, initial stages of reduction. In such a setting the amount of cortex on the piece will be a relatively good predictor of the stage of removal. The following attribute states have been recognized in lieu of more general categories of spalls to maintain consistency amoung the other attribute observations and also to permit analyses which treat the amount of cortex as an ordinal variable.

00 indeterminate- the amount of cortex on the piece cannot be determined.

01 None

02 1-25%

03 26-50%

04 51-75%

05 76-100%

09 NA

When this observation is made on spalls, the percentage cortex refers to that which occurs on the dorsal surface of the spall; when the observation is made on a core or blank/preform, the observed percentage cortex refers to the total surface area of the piece. In every case these observations were measured intuitively.

VIII Platform Thickness

Platform thickness is measured to the nearest 0.1 mm as the greatest dimension on the platform from the ventral edge to the dorsal edge. This measurement has been made to permit technological assessments of artifact size in situations when the artifact is highly fragmented. Strong correlations between platform size and spall size have been

For cores, the width is measured as the maximum dimension from one lateral edge of the core to the other--i.e. across the primary working face of the core.

For blanks/preforms and projectile points the width is measured at the widest point of the piece on the plane of the bifacial edge, approximately perpendicular to the length.

XII Artifact Thickness

For spalls, this is measured as the maximum dimension from the ventral to the dorsal surfaces of the piece distal to the bulb of percussion.

For cores, the thickness is measured as the maximum dimension from the main working face to the opposite surface, approximately perpendicular to the width.

For blanks/preforms and projectile points, this measurement is taken as the maximum dimension of the piece perpendicular to the plane of the bifacial edge.

XIII Core Class

These categories express aspects of both core and blank/preform morphology, reduction stage, and or removal pattern.

00 indeterminate

core categories:

01 single platform- the core has only one platform which has been unidirectionally flaked.

02 opposed platform- the core has two platforms which are on the same plane and therefore have flake scars which overlap. These may either be on a 180^{o} axis, this is directly opposed, or between 90^{o} are classified as single platform cores.

03 multiple platform- these cores have more than two platforms, which are on different planes of the core and thus do not have overlapping flake scars.

biface categories: each of these categories simply expresses the relative portion of the circumference of the biface platform which has been flaked--the maximum of course being 360°. Since almost all preforms and projectile points have been flaked around their entire circumference, this observation is designed more to shed light on the extent to which the blank or early preform has been worked. Used as an ordinal scale measurement of a reduction progression, this observation is an aid in the analysis of size variability among the bifaces.

The following categories express the proportion of the bifacial edge which has been worked (note LT= less than, GT=greater than)

04 LT 90°

05 GT 90°, LT 180°

06 GT 180°, LT 270°

07 GT 270°, LT 360°

08 360°

09 NA

XIV Blank Form

This observation indicates the kind blank which was used for the manufacture of a tool, core, or blank/preform.

00 indeterminate- the piece is totally flaked, obscuring the blank form.

01 nodule- a naturally occurring nodule of lithic material was used for the blank.

02 Flake- a spall of some sort was used as a blank, as indicated by features such as a bulb, ventral surface, etc.

03 NA

Table D-2. Assemblage composition of selected sites at Fort Sill, Oklahoma. Figures shown are relative frequencies, with sample sizes indicated in last column.

Site					Lithic Artifact Class									
	Debitage	Cores	Blank/preform	Other biface	Projectile point	Scraper	Retouched piece	Notch	Drill	Burin	Ground stone	Varia	Hammerstone	Total Number
Cm-														
20	94.2		1.0			1.9	1.9				1.0			103
38	78.5	7.7	4.6	3.1			4.6					1.5		65
58	78.3	8.3		.9	.9	1.7	3.5	.9		.4		3.9		230
65	86.6	2.7	2.7		1.3		6.7							75
67	71.6	5.3	2.7	2.7	2.2	1.3	8.9	2.2				2.7	.4	225
68	80.6	6.5	3.2				6.5					3.2		31
69	80.5	3.6	1.0	3.4	2.9	1.0	4.6	.7	.2			2.2		416
71	81.5	2.5	7.4	1.0	1.5		3.4			.2	.4*	1.5	.6	524
72	74.7	2.4	1.2	1.2	4.8	3.6	2.4	3.6				6.0		83
74	92.4	1.5	1.5		1.5		1.5				1.5			66
92	73.7	18.4		5.3								2.6		38
93	80.0	7.5				1.5	5.0					5.0		40
233	81.1	2.7	2.7			2.7	5.4						5.4	37
234	81.9	9.6	1.2	1.2		1.2		.6				3.6	.6	166
235	85.9	1.2	3.1			.6	3.7	.6	.6			4.3		163
236	100.00													20
237	75.9	6.9	6.9	3.4		3.4					3.4			29
238	81.8	18.2												11
239	94.8	.6	1.7			1.1	1.1	.6						174
240	94.3			2.9	2.9									35
241	80.0	5.0	5.0		10.0									20
242	78.0	12.2				2.4	7.3							41
246	75.0	6.1	4.8		.9	1.3	3.1	.4		.4		7.9		228
247	95.0	5.0												20

Cm–													
249	90.8	1.1	.5	1.1	1.1	1.1	1.1		.5	.5	1.1	1.1	185
275	33.3				66.7								3
276	100.0												21
277	91.7		4.2				4.2						24
280	70.6	23.8	4.2				1.4						143
282	94.4		5.6										18
283	79.3	3.4			3.4		10.3				3.4		29
285	88.6	1.4		1.4	1.4	1.4	1.4				4.3		70
288	100.00												16
289	82.4	15.7	2.0										51
290	75.0	25.0											8
291	78.5	10.3	.9	.9	.9	1.9	5.6				.9		107
292	66.7	33.3											12
294	88.9						11.1						9
295	95.0	2.5										2.5	40
296	66.7	16.7	16.7										6
297	100.0												13
298	76.9	19.2					3.8						26
299	88.9	11.1											9
301	81.8	6.1	4.5		1.5	4.5						1.5	66
302	90.9					9.1							11
303	72.6	6.8	11.0	1.4	2.7	1.4	4.1						73
305	86.6	1.1	10.8		.4	.7	.4						277
306	76.6	2.1	3.2	2.1	3.2	4.3	7.4				1.1		94
308	84.6	10.3	5.1										39
309	69.6	4.3	21.7			4.3							23
310	87.5	8.3				4.2							24
311	69.2	30.8											13
312	80.8	2.9	5.8	1.9	4.8	1.0	1.0	1.0			1.0		104
313	81.0	3.4	3.4	1.7	1.7		5.2				3.4		58
315	89.5	4.3	6.2										209
316	87.5	9.4					3.1						32
317	78.1	11.0	2.6			.6	5.8*	.6			1.3**		155
318	82.8	15.1				1.1	1.1						93
320	76.1	2.8		2.8	8.5	1.4	7.0					1.4	71
321	90.0	10.0											10

* One Celt Included
** Clearfork Gouges

ed assemblages a [redacted] rt Sill.
cies in percentage [redacted]

Quartz "B"	Tecovas	Rhyolite	[redacted]	Other Chert	Other	Total Number
.9	1.9	1.0	[redacted]	23.3	4.9	103
.5			[redacted]	16.9	10.7	65
5.5	.9	4.3	[redacted]	24.3	3.5	230
2.7		5.3	[redacted]	20.0	8.0	75
6.7		7.1	[redacted]	26.2	3.6	225
			[redacted]	74.2		31
2.3	1.2	5.5	[redacted]	19.7	4.8	416
5.5		1.9	[redacted]	16.4	3.1	524
3.6	9.6	6.0	[redacted]	19.3	6.0	83
4.5		1.5	[redacted]	16.7	4.5	66
1.1			[redacted]			38
5.0			[redacted]	15.0	15.0	40
			[redacted]	56.8	2.7	37
3.4		3.6	[redacted]	6.0	3.0	166
4.9		.6	[redacted]	30.1	1.2	163
5.0			[redacted]	35.0	5.0	20
			[redacted]	27.5	20.6	29
9.1			[redacted]	18.2	9.1	11
1.1		2.9	[redacted]	25.2	2.3	174
0.0			[redacted]	2.9		35
5.0			[redacted]	25.0		20
			[redacted]	17.1	2.4	41
25.0	.4		[redacted]	15.3	1.3	228

Cm-													
247						100.0							20
249	.5	.5	55.1	.5	3.2	3.2	.5	.5	.5		24.3	10.8	185
275									33.3		66.7		3
276						19.0	9.5	52.4			19.0		21
277	4.2		8.3			29.2	4.2	33.3			16.7	4.2	24
280						78.3		6.3			14.0	1.4	143
282						72.2		27.8					18
283		6.9	10.3			65.5		3.4			10.3	3.4	29
285			11.4	4.3		40.0	2.9	7.1	2.9		24.2	4.3	70
288		87.5									12.5		16
289						92.2						7.8	51
290						50.0					25.0	25.0	8
291	1.9		.9		.9	12.1	5.6	64.5		2.8	6.5	4.7	107
292						83.3		8.3		8.3			12
294						22.2		66.7			11.1		9
295						17.5	5.0	25.0	2.5		50.0		40
296						100.0							6
297						30.8		38.5			30.8		13
298						76.9		7.7	11.5		3.8		26
299		22.2				77.8							9
301						81.8		9.1	1.5			7.6	66
302						72.7		9.1			9.1	9.1	11
303		9.6	1.4			6.8	1.4	69.9	2.7	1.4	6.8		73
305						76.9					.4	22.7	277
306	2.1		7.4			57.4		1.1	1.1	2.1	21.3	7.5	94
308						82.1			2.6		5.1	10.3	39
309						100.0							23
310						54.2		16.7			29.2		24
311						76.9		15.4				7.7	13
312	1.9		11.5		9.6	42.3		1.0	1.9		27.9	3.8	104
313						81.0		5.2	1.7		12.1		58
315						98.1	.5	1.4					209
316	3.1					18.8		68.8		3.1	6.3		32
317	.6		3.9			27.1	9.0	47.1	1.9	1.9	5.8	2.5	155
318						15.1		83.9				1.1	93
320	1.4		5.6		1.4	18.3	1.4	18.3		1.4	47.9	4.2	71
321						50.0	10.0	40.0					10

Table D-4. Platform types on debitage from selected assemblages from Fort Sill. Figures shown are relative frequencies in percentages.

SITE	PLATFORM TYPE				
	Cortex	Unfacetted	Facetted	Crushed	Total Number
34-Cm- 20	3.7	68.5	9.3	18.5	54
38	10.7	60.7	10.7	17.9	28
58	10.4	55.2	23.1	11.2	134
65	3.0	72.7	15.6	9.1	33
67	8.5	22.6	65.1	3.8	106
68	20.0	6.7	66.7	6.7	15
69	11.4	33.2	42.3	13.2	220
71	10.9	35.4	28.1	25.5	274
72	9.7	12.9	17.7	6.5	29
74		72.2	13.9	13.9	36
92	29.2	54.2	12.5	4.2	24
93	7.7	50.0	26.9	15.4	26
233	5.9	29.4	58.8	5.9	17
234	26.7	30.2	20.9	22.1	86
235	12.0	29.3	56.0	2.7	75
236		80.0		20.0	10
237	15.4	53.8	7.7	23.1	13
238	14.3	28.6	28.6	28.6	7
239	4.5	74.2	15.2	6.1	66
240	8.7	34.8	39.1	17.4	23
241		80.0	20.0		10
242	25.9	25.9	25.9	22.2	27
246	10.0	37.8	30.0	22.2	228
247	41.7	25.0	25.0	8.3	12
249	2.7	68.5	20.5	8.2	73
275		100.0			1
276	33.3	55.6	11.1		9

3.3	26.7	15
8.3		81
	8.3	12
5.0	12.5	16
7.5	5.0	40
	16.7	12
		3
	10.7	56
5.5	25.5	4
9.0	4.8	21
		8
5.3	11.8	17
		7
9.3	11.6	43
		8
7.4	2.1	47
5.5	11.0	200
8.2	9.1	44
7.1	10.7	28
7.7	15.4	13
2.5		8
22.7	22.7	44
15.5	6.1	33
2.7	8.9	112
4.3	26.1	23
26.5	19.3	83
14.1	21.1	71
0.3	23.1	39
25.5		4

APPENDIX E

DATA BASE FOR SUBSISTENCE MODEL

by

Britt Bousman

The estimates of bison, elk, and antelope densities were based on carrying capacity figures for short, mixed, and tall grasslands given by McHugh (1972:16). This method is based on the maximum number of domestic cattle that can graze on a given area of land without damaging the plant community while considering both wet and dry years. McHugh suggests that the grazing pressure of a bison is not significantly different from that of a domestic cattle. He states that in the western half of the Tall Grass Prairie one cow or bison would require 20 acres, in the Mixed Grass Prairies a bison needs 26 acres, and in the Short Grass Plains one bison needs 45 acres. No estimation is given for the forest communities but both McHugh (1972:153) and Roe (1951:334-520) suggest that populations of bison were less dense in wooded environments than in grasslands. If the Wichita Mountains can be considered a forest community then it requires 34 acres per cow (Halloran and Glass, 1959:361-369).

Halloran (1964:40) has ranked Texas Longhorn cattle, bison, elk,

region from one plant community to another, the A.U. were computed for both forest and grasslands.

Table E-1 Regional Resource Values

Species	Season	Weight	Number	Density	A	t	h1 time	h1 size	h2 time	h2 size	h3 time	h3 size
Bison	1	318	1.1	2.5	50	44056	0.9	0.84	0.1	0.16		
	2	318	1.1	2.5	200	"	0.9	0.84	0.1	0.16		
	3	318	1.1	2.5	100	"	0.9	0.84	0.1	0.16		
	4	302	1.2	2.5	100	"	0.8	0.84	0.2	0.16		
Elk	1	130	1.1	0.44	15	51	0.5	"	0.5	"		
	2	130	1.1	0.44	40	51	0.75	"	0.25	"		
	3	130	1.1	0.44	15	51	0.5	"	0.5	"		
	4	124	1.15	0.44	15	51	0.25	"	0.75	"		
Deer	1	32	1.1	2.52	3	10.4	0.25	"	0.75	"		
	2	32	1.1	2.52	3	10.4	0.20	"	0.80	"		
	3	32	1.1	2.52	7	10.4	0.15	"	0.85	"		
	4	32	1.15	2.52	3	10.4	0.1	"	0.90	"		
Antelope	1	26	1.1	1.0	4.	8741.75	.9	"	0.1	"		
	2	26	1.1	1.0	4	"	.9	"	0.1	"		
	3	26	1.1	1.0	10	"	.85	"	.15	"		
	4	26	1.15	1.0	4	"	.80	"	.20	"		
Small Game	1	0.8	1.05	50	1.5	0.2	1.0	"	1.0	"		
	2	0.8	1.05	"	1.5	0.2	1.0	"	1.0	"		
	3	0.8	1.05	"	1.5	0.2	1.0	"	1.0	"		
	4	0.8	1.1	"	1.5	0.2	1.0	"	1.0	"		

Table E-1 Regional Resource Values Continued

Species	Season	Weight	Number	Density	A	t	h1 time	h1 size	h2 time	h2 size	h3 time	h3 size
Beaver	1	9.7	1.1	0.21	3	0.4	1.0	0.023				
	2	11.3	1.1	0.21	"	"	"	"				
	3	11.8	1.1	0.21	"	"	"	"				
	4	10.8	1.15	0.21	"	"	"	"				
Mussel	1	0.009	1.1	4000	500	0.01	1.0	.0004				
	2	"	"	"	"	"	"	"				
	3	"	"	"	"	"	"	"				
	4	"	"	"	"	"	"	"				
Fruits	1	–	1.0	–	1	0.0001	–	–	–	–	–	0.8661
	2	0.0345	1.0	1201.3	1	0.0001	1.0	.0244	1.0	0.1089	1.0	
	3	0.3039	1.0	305.5	1	0.0001	1.0	.0244	–	–	–	–
	4	–	1.0	–	1	0.0001	–	–	–	–	–	–
Roots	1	0.007	1.0	231.35	1	0.0001	1.0	.0244	1.0	0.1089	1	0.8661
	2	0.0204	1.0	1472.24	1	0.0001	1.0	"	"	"	"	"
	3	0.03	1.0	78.88	1	0.0001	"	"	–	–	–	–
	4	0.03	1.0	57.88	1	0.0001	"	"	–	–	–	–
Nuts	1	–	–	–	–	–	–	–	–	–	–	–
	2	–	–	–	–	–	–	–	–	–	–	–
	3	8.1792	1.0	391.15	1	0.0001	1.0	.0244	1.0	0.1089		
	4	–	–	–	–	–	–	–	–	–	–	–

A– Aggregation size of Resource (Numbers of Individual Animals)
t – Size of Resource Territory by Season (In Km^2)
h^1 Time – Percent of Total Time per Season spent by Habitat
h^1 Size – Percent of Area per Season spent by Habitat
For Further Explanation of Table Headings See Chapter 9

of the region for that species was its territory size. For bison this would be the entire region or 44056 Km^2 and for antelope it would be 8741 Km^2 or the area it historically inhabited. Small game, beaver, and mussel as well as the plants were estimated given what was known about seasonal or yearly movements.

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